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SCIENCE

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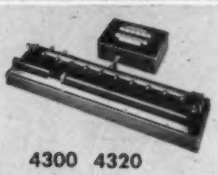

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PLANNING UNPLANNED RESEARCH: You can't plan to make discoveries. But you can plan work that will probably lead to discoveries.

Dr. Willis Whitney discovered a word which is in the dictionary—serendipity—and I don't like the definition that is given. Let me suggest this one: "The art of profiting from unexpected occurrences." Now, it seems to me a large part of the Laboratory work is based on that. You don't know all the things that are going to happen; too many of them are unexpected. But it is these unexpected things that are going to be the most profitable—the most useful—things you do.

The old idea of physics was that everything was perfectly, definitely due to causality. There was a definite relation of cause and effect. And that worked perfectly well in classical physics. But, then, years later came the quantum theory and the uncertainty principle of Heisenberg. But Bohr, five or ten years before Heisenberg's uncertainty principle, had the idea of the correspondence and uncertainty principles very clearly in mind. I remember Bohr saying that if a thirteen inch shell is coming toward you, several thousand feet a second—headed right toward you—it may pass through you and produce no effect whatever. There is a certain, definite chance that this will happen—very small.

Take another example. You can see the track of an alpha particle. It's one quantum effect—a radium atom exploded. Fundamentally, you can't find the cause for such things. In fact, as Bohr pointed out very clearly, if you could find out what it is that sets off a radium atom after 2000 years, then the whole of quantum mechanics would have to go by the board. It's basic that those must be the fundamental things, the probability, and not the cause of the definite action. All right, if an alpha particle can leave a track and a man can do something as a result of it—see it, for example—he may either get killed or not get killed because of timing. He may be run over by an automobile because he left his office a little later than he otherwise would have.

Come down to human affairs—an idea, for instance. How did it begin? Why, with something as small as a quantum, or the actions of a lot of separate quantums, of course. You have the dividing of the ways. Either you do one thing or the other. You continue to have alternatives. These alternatives may determine things of tremendous importance.

If you can't predict ideas, you can't plan things in a laboratory. But you can organize a laboratory so as to increase the probabilities that useful things will happen there. And, in so doing, keep the flexibility, keep the freedom. That's what freedom is for. All of us in this Research Laboratory are interested in freedom. We know from our own experience that in true freedom we can do things that could never be done through planning. That's why we are going to beat out Russia in the long run.

Stalin believes that everything can be planned. Marx believed that everything could be planned. That's the trouble with all dictators. They think that they can run the world by planning from above. And that is an utter impossibility, basically and fundamentally, because of the existence of divergent phenomena.

The moment that you see that the world isn't a kind of place where complete planning is possible, then you believe in democracy, you believe in freedom and initiative—in all the kinds of things that can be planned only in very general ways, not in detail.

I think, no matter how far you may go in dictatorship, no matter how far it may succeed, it will ultimately fail because of the impossibility of planning on a world-wide scale.

Now, in the Laboratory we have a good example. I think most of us here have ideas of freedom and of the importance of thinking things out in our own way. Human virtues, such as curiosity, initiative, interest in things and just doing things for the fun of it, add up to me as just one of the things you realize in this Laboratory. And if only it could be that way on a world-wide scale, we would be much better off than we are now.

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Taxonomy of Mental Disease

THE categories used by psychiatrists have puzzled scientists in other fields. As frequently occurs in the "natural history" state of a new field of investigation, our present taxonomy owed its origin to historical accident and has persisted because of failure to devise an adequate substitute for the admittedly inexact terminology and classifications. The clinical observations that led Kraepelin to group mental diseases as he did are still valid. There exist, however, a great number of alternate methods of grouping that have arisen as the result of improved techniques in neighboring fields. Endocrinologists, biochemists, psychologists, sociologists, and workers in other disciplines have proffered such classifications. The psychiatrist has rightfully resisted new groupings which may suit some other discipline, but which would fit our clinical material even less satisfactorily than the present Kraepelinian terminology.

The acceptance of Kraepelin's classification resulted not so much from the pertinence of his categories, as from Bleuler's rationalization for Kraepelin's groupings in his classic monograph. In the light of our current knowledge of scientific theories this rationalization is inadequate, since it lacks both exclusiveness and predictability. Further, the associationist theory and the elementarism of mind on which Bleuler's theory was based are no longer acceptable.

The failure of allied disciplines in making major contributions to the field of mental disease has been most discouraging. This failure may be due to malapropos or phenotypical groupings of patients with mental disease, rather than to biochemistry, neuropathology, endocrinology, etc. A system of classification is needed which will mutually satisfy the psychiatrist and scientists in related disciplines.

D. L. Gerard and I have proposed a new approach to this problem (Taxonomy of Mental Disease. *J. Gen. Psychol.* [in press]). We have offered, not a new taxonomy, but a proposal as to how such a taxonomy should be evolved. The method involves two essential considerations: (1) That the "psychiatry" of an individual is an end product of processes which themselves are not essentially psychiatric, and an adequate taxonomy should, therefore, be capable of subsuming and incorporating data provided by all related disciplines in terms of which these individuals could be classified. The "abnormal" is thus continuous with all other areas of human behavior and is used to designate certain patterns of attributes. Search for these attributes and determination of their relatedness are functions of research in psychiatry. (2) By the technique of cluster analysis, in which items for the clusters are drawn not only from psychopathological symptoms but from any or all of these related disciplines, it would be possible to differentiate individuals into discriminable types, and to establish the relatedness of an individual to any specific pattern of "abnormality." Observation of many individuals through time, in physical and social space, should lead, by way of conceptual perceptions, to a restructuring of the field into meaningful configurations of operationally demonstrable attribute clusters which would appear as "figures" on the ground of the assertable total attributes of the population.

Previous attempts at establishing psychiatric taxonomy have not included the total field of assertable and pertinent attributes, and have imposed a priori "idealized" categories, instead of allowing experimentally determined attribute clusters and relationships to suggest adequate categories and principles of organization.

Preliminary experimental work carried out cooperatively by Worcester State Hospital, the Worcester Foundation for Experimental Biology, Worcester Memorial Hospital, and Clark University, and supported in part by the Wenner-Gren Foundation, has utilized attributes drawn from biochemistry, neurology, morphology, psychopathology, and physiology. We plan to extend the approach to include sociology, psychology, and histology. Success in this field might well suggest similar application to other biological problems.

NATHAN S. KLINE

Worcester State Hospital
Worcester, Massachusetts

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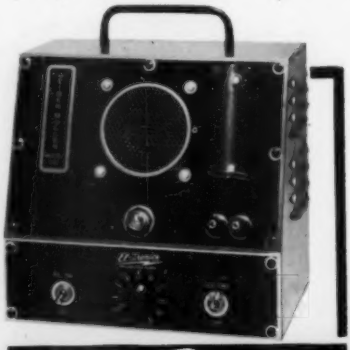

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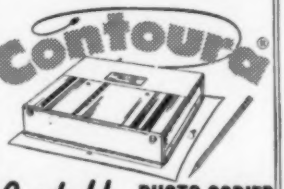

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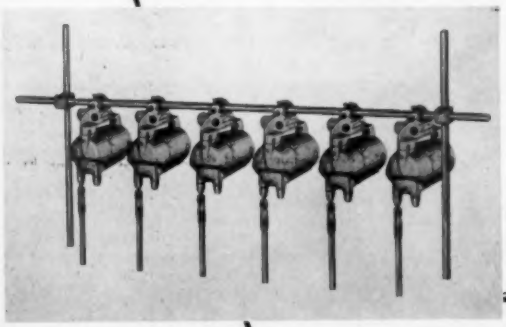

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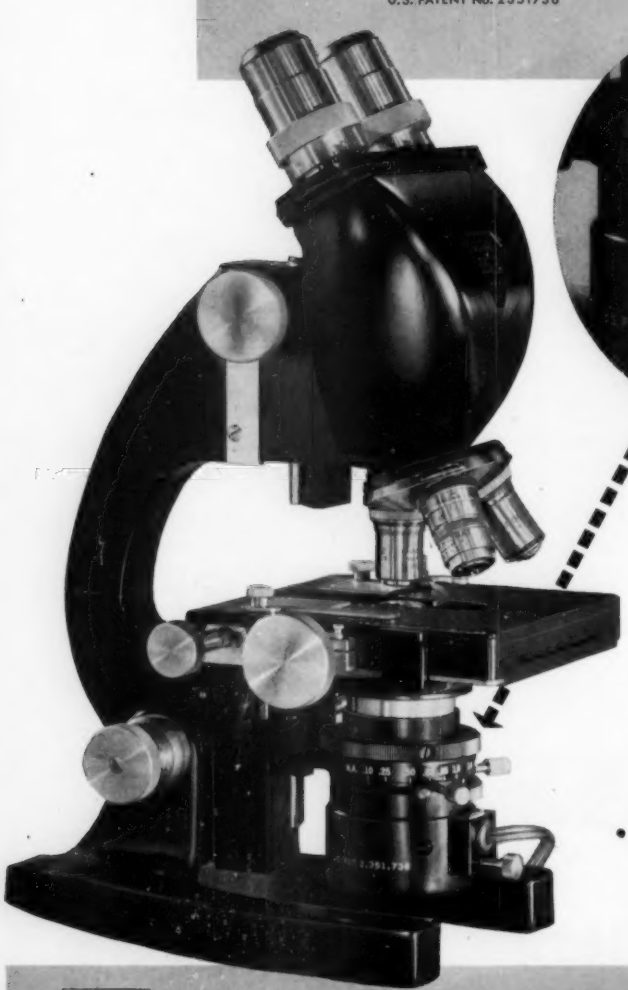

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The Artificial Kidney

A. V. Wolf

Department of Physiology and Pharmacology, Albany Medical College, Albany, New York

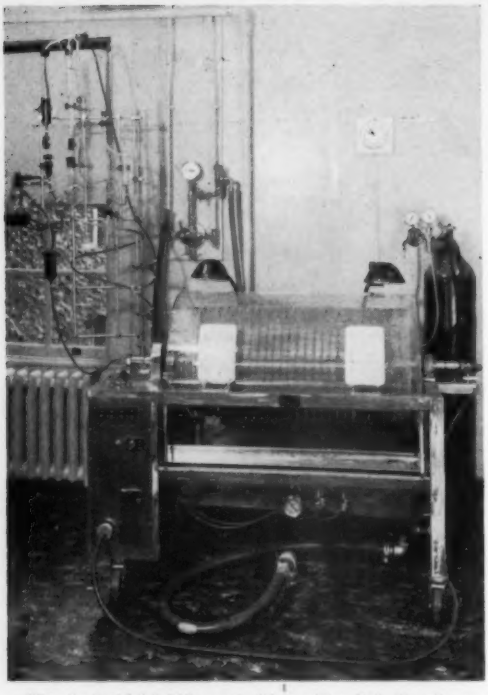
IN PRINCIPLE AN ARTIFICIAL KIDNEY is a differential dialyzer. Thirty-eight years ago a small one was first described by Abel, Rowntree, and Turner (*1–3*). Their device, connected to an artery of an animal, permitted blood to traverse celloidin tubes surrounded by a bath of salt solution and to return to the animal through a vein. Through hemodialysis, crystalloids present in the blood plasma but not in the bath fluid diffused into the bath. Subsequent attempts at "vividiffusion" were made by others, but technical difficulties lying between hemodialytic principle and widespread application were so forbidding that the whole matter remained quietly confined to academic circles until about seven years ago. At that time W. J. Kolff (*4, 5*), of Holland, cut the Gordian knot and put the principle of the lecture room to work in the hospital. Since then artificial kidneys have multiplied in design and number (*6–17*), and their clinical status is becoming clear even though unforeseen developments may change conditions at any time. At present they hold singular promise as experimental tools; but, if technique can be highly perfected, there is no discernible limit to the novelty, wealth, and importance of hemodialytic explorations.

Fig. 1 shows one kind of modern artificial kidney. Its distinctive features—the use of the quasi-Archimedean screw to move blood through the cellophane dialyzing tubing, and the 100-liter bath—are derived from the original Kolff kidney, but it embodies extensive improvements over the latter, in consequence of the painstaking efforts of investigators at Peter Bent Brigham Hospital in Boston (*13, 14*). These machines, properly used, are thoroughly reliable.

Two cannulas are placed by a surgeon, one in the radial (wrist) artery and one in a vein on the inner aspect of the same arm at the elbow. A sterile cellophane "sausage casing" about 115 feet in length has previously been wrapped about the wire mesh drum in a closely coiled helix, and its ends adapted to terminal couplings ("arterial" and "venous"). These devices permit the drum and cellophane to be rotated by a motor without disturbing the tubes leading blood to the arterial and from the venous coupling. Banked blood, perhaps 400 ml, and some physiological saline are used to "fill" the machine initially, and heparin is administered through the venous cannula so that the patient's blood will not clot in its passage through the artificial kidney. Arterial pressure drives blood through the arterial coupling into the flattened cellophane tubing, where it sinks to the lowest portion of the loops during the rotation of the helix. This blood, the pressure of which is now negligible, is literally rolled to the venous coupling. From this point it is pumped through a pair of plastic valves by an air piston (minimizing the trauma to which the blood cells are subjected) and raised several feet above the bed level of the patient. It is led into a buret from which, by gravity, it drains through a protective clot-catching funnel containing glass beads, and then back to the patient's vein. One of the important responsibilities of the operating hemodialyst is to prevent the blood content of the patient from fluctuating widely during treatment, and he is attentive to the blood balance, seeing that nearly equal quantities of blood are lost to and gained from the machine per unit time.

Just before the extracorporeal circulation is started, the bath, prepared with 100 liters of a solution containing major electrolytes of the plasma, is motor-hoisted so as to immerse the lower portion of the dialyzing coils. All parts of the system in contact with blood are sterilized before operation, except for the bath fluid, since microorganisms do not, and viruses apparently do not, penetrate the cellophane. The concentrations in the bath fluid of electrolytes such as sodium, potassium, calcium, magnesium, bicarbonate, and chloride approximate their concentrations in normal plasma, although for particular purposes fluid of any desired composition can be used. A mixture of 5 per cent carbon dioxide and 95 per cent oxygen is passed steadily through the space between the surface of the fluid and the plastic cover of the bath. The carbon dioxide, equilibrating with bath fluid, enables calcium to remain in solution with bicarbonate. Metabolites such as urea and creatinine are, of course, absent from the virgin bath. This permits a differential dialysis with, for example, little net change of sodium, while urea and creatinine move from blood to bath readily along their blood-bath concentration gradients. A 6-hour hemodialysis produces striking changes in the chemical composition of body fluids. An abnormally high blood level of urea, reflecting essentially an abnormally large quantity of urea dissolved throughout body water, may be reduced to one half or one third (Table 1). Excesses of potassium, deficits in bicarbonate, and, in general, almost any aberrations of electrolyte concentration in the plasma are sharply reduced.

There is some control of water balance, but this remains to be improved. Since there is no appreciable hydrostatic pressure gradient across the wall of the cellophane casing and no colloidal material in the bath fluid, the osmotic pressure of the plasma colloids



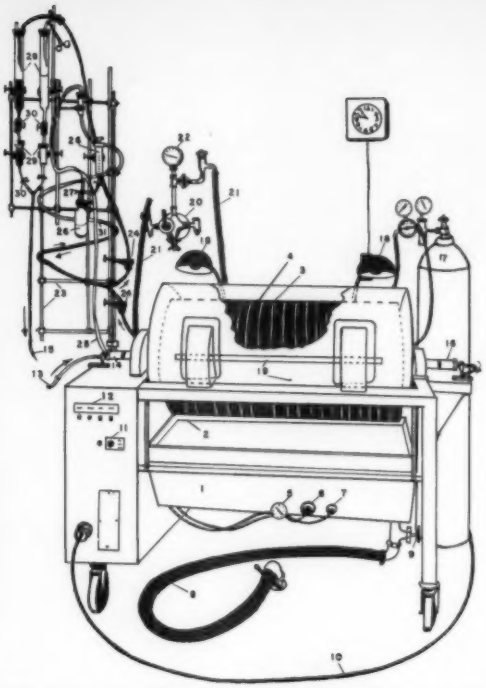


FIG. 1. Artificial kidney at Albany Hospital. For demonstration, the flask (extreme left) and large buret below and to the right of it are partly filled with blood, simulating patient. These are omitted from line drawing of the photograph at right. The cellophane coils about the wire mesh drum are seen behind and below the transparent plastic cover of the bath. The bath itself is in the DOWN position, and its fluid level is visible. Only one of the pair of air-trap burets with attached clot catcher is used at a time. The other set is in reserve.

Right: Diagram of machine in photograph. 1, bath pan; 2, bath fluid level; 3, wire mesh drum; 4, cellophane tubing; 5, thermometer; 6, bath light socket; 7, thermoswitch set to maintain bath fluid at 100° F; 8, drain for bath; 9, drain faucet; 10, electric cable supplying lights, motor-hoist for bath, bath fluid heater, rotation drive for wire mesh drum, and pump for air piston; 11, UP-DOWN switch for bath; 12, HEATER, LIGHTS, and ROTATION-DRIVE switches; 13, arterial cannula; 14, arterial coupling; 15, venous cannula; 16, venous coupling (blood goes from here through the tube passing behind the machine to the lower of the pair of valves); 17, tank of 5% CO_2 and 95% O_2; 18, gooseneck lamp; 19, transparent plastic cover of bath and handle for raising; 20, mixing valve for providing water at body temperature to fill bath; 21, water hose; 22, thermometer of mixing valve; 23, supporting rods; 24, plastic valve; 25, rubber tube from air compressor (pump) in housing to blood flow control apparatus; 26, blood flow control apparatus; 27, petcock for adjusting rate of blood flow from venous coupling; 28, plastic air-trap buret; 29, clot catcher; 30, adjustable clamp; 31, interface of blood and air (piston), which oscillates up and down in the winding plastic tubing during pumping.

promotes a tendency for fluid from the bath to enter the blood. If unchecked, the resulting hydration could have serious clinical consequences, such as pulmonary edema. The movement of fluid into the blood is retarded or reversed by adding glucose to the bath. However, precise regulation of fluid exchange cannot be obtained in this manner, because glucose passes across the cellophane (Table 2), changing the glucose gradient,[1] and because osmosis under these conditions is a function of blood flow, which is changeable. Moreover, the protein content of plasma is variable. Ordinarily 0.7 per cent glucose in the bath fluid seems clinically satisfactory, but considerably higher concentrations have been used to dehydrate patients (*5, 17, 18*). If enough glucose is added to the bath, the fugacity, or escaping tendency, of the bath fluid becomes less than that of the plasma (*19*). The plasma consequently loses protein-free fluid to the bath, its oncotic pressure rises, and its fugacity with respect to interstitial accumulations of fluid is lowered. Thus, an osmotic siphon is started in which the plasma assumes the role of a conductor of fluid. Interstitial (edema) fluid moves "uphill" to the higher hydrostatic pressure of the blood stream, through the plasma fluid, and then "downhill" to the lower hydrostatic pressure of the bath fluid. In the hemodialyzer of Alwall (Fig. 2) water balance is controlled by regulating directly the hydrostatic pressure of the bath fluid relative to that of the blood (*7, 8*); and the ultrafiltration principle has been used in other forms (*15, 20*), as in Figs. 3 and 4.

An interesting phenomenon results from the fact that, as dialysis proceeds, concentration gradients between blood and bath tend to decrease, diminishing the rate of transfer of certain solutes. In order to aug-

[1] Other osmotically effective materials have been considered or used—e.g., gelatin, Carbowax, sucrose, etc.

TABLE 1

COMPARISON BETWEEN ARTIFICIAL AND NATURAL KIDNEYS

Feature	Artificial kidney*	Human kidneys (normal)
1. Number of nephrons	1	2,000,000
2. Surface area for exchange or excretion	21,000 sq cm (cellophane)	8,000 sq cm (glomerular capillaries) 60,000 sq cm (tubules)
3. Blood pressure	Less than osmotic pressure of plasma colloids	Greater than osmotic pressure of plasma colloids
4. Blood flow	100–500 ml/min	1200 ml/min
5. Time required for blood to pass through kidney	4–1.8 min	0.02 min
6. Quantity of blood in kidney	400–1040 ml	24 ml
7. Principles of excretion and regulation	Diffusion primarily, some filtration	Filtration, reabsorption, secretion
8. Urea (at plasma level of 300 mg %)†		
a, Excretion	68%/6 hr (2 bath changes) 102 g/6 hr (2 " ") 57%/6 hr (no bath change) 85 g/6 hr (" " ")	42%/6 hr‡ 63 g/6 hr‡
b, Clearance	Falls with time—e.g., 175 ml/min at zero time, 135 ml/min at 2 hr	Independent of time, e.g., 75 ml/min
c, Half-life	3.7 hr (1 bath change after 2 hr)§ 4.4 hr (no bath change)§	7.7 hr
9. Weight	> 400 kg	0.3 kg

* Shown in Fig. 1.
† Ignoring rate of urea formation.
‡ A diseased kidney would put out much less and might be responsible for the high plasma urea.
§ See qualification in text.

ment their exchange, the bath can be drained and refilled with fresh fluid one or more times during a run. It has been shown (*18, 21*) that maximal augmentation occurs if the time intervals between n changes of bath fluid in a total dialytic operating time t are equal to $t/(n+1)$. If one optimal change is thus made at 3 hours in a total operating time of 6 hours, urea removal under specified conditions might be augmented 16 per cent above what would have occurred with no bath change. For the same conditions, but with two changes at 2 and 4 hours, the increment would be 20 per cent. Similarly, for an infinite number of changes the increment would be 31 per cent. This indicates how close to the dialyzing limit of the cellophane it is possible to work with only two changes. It points up further the limits of counterflow dialyzers, which approach in varying degree, but never equal, the efficiency obtained with "an infinite number of changes."

It is of interest to assess the operation of artificial

TABLE 2*

Substance	*D*	*d*	*E*
Chloride	310	1.03	0.61
Urea	300	*1.00*	.60
Potassium	300	1.00	.60
Sodium	235	0.78	.47
Creatinine	169	.56	.34
Bicarbonate	168	.56	.34
Alanine	148	.49	.30
Glucose	120	.40	.24
Magnesium	100	.33	.20
Inorganic phosphate	92	.31	.18
Sucrose	67	.22	.13
Phenol red	33	0.11	0.07

* Average dialysances (D) and relative dialysances (d) obtained at a "plasma flow" (a) of 500 ml/min. The extraction fraction (E) given here is the fraction of solute removed from arterial plasma in one passage through the cellophane casing by a virgin bath containing none of the solute. For a substance x, $E_x = D_x/a$. As blood flow approaches zero, all these extraction fractions and relative dialysances approach 1.0 (*18*).

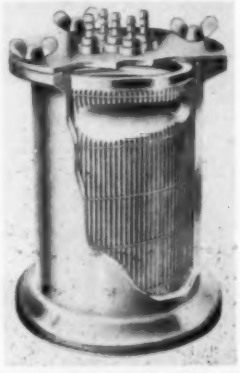


FIG. 2. A hemodialyzer-ultrafilter, intended for rabbits. Cellophane tubing (700 sq cm, not shown here) is wound helically around the inner fluted cylinder, which is provided with a bottom, fitting in the narrow space between inner and outer cylinders. The small volume of bath fluid contained in the apparatus is steadily replaced, entering one of the taps in the top-plate and passing through a rubber tube connected to another tube in the bottom of the inner cylinder. From there it flows over the surfaces of the cylinders and in thin layers around the cellophane, leaving the apparatus through a tap on the top-plate. With a controlled bath fluid inflow, the effluent is allowed to pass through a long rubber tube, discharging at a variable but lower level than the apparatus. The degree of negative pressure of the bath fluid on the outer surface of the cellophane tubing (and, consequently, the filtration pressure) can thus be regulated (*8*).

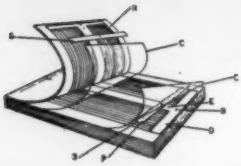


FIG. 3. An assembly of 4 units of a counterflow hemodialyzer in parallel. Two such assemblies in series have 12,000 sq cm of cellophane sheet and contain 400 ml blood. The top rubber pad has been bent back to show the relative positions of the inner parts. *R*, grooved rubber pads; *C*, cellophane sheets; *S*, stainless steel plates between the two sheets of cellophane—these plates are separated 1 mm by projections (*P*) in one of the plates; *D*, depression in rubber pads to accommodate the steel plates; *B*, interconnecting tubes for blood—the holes in the steel plates fit exactly over *B*; *E*, interconnecting tubes for dialyzing solution. Several units may be used in series and/or in parallel (*10*).

kidneys against an elementary background of natural kidney function. One human kidney contains about 1,000,000 units called nephrons, each having an intimate blood supply for its two major portions, the glomerular capsule and the tubule. A tiny ball of capillaries, the glomerulus, invaginates the dilated tip of the tubule so as to be almost surrounded by a double-walled capsule. The combined capillary-capsule barrier is relatively impermeable to colloidal constituents of the plasma such as proteins but rather freely permeable to its water and crystalloids. Largely because the hydrostatic pressure of the blood within the glomerular capillaries exceeds the colloid or effective osmotic pressure of the plasma, there occurs a filtration of essentially protein-free fluid from the plasma, across the barrier, into the tubule. As this filtrate courses along the tubule, its dissolved materials may be selectively reabsorbed in whole or part, or added to by tubular secretion; or, they may suffer no change in quantity. About 120 ml of glomerular filtrate are thought to form each minute in the collective 2,000,000 glomeruli of an adult, and the tubular cells ordinarily reabsorb about 99 per cent of the filtered water, returning it to the blood stream. The remaining fluid, whose composition is now qualitatively similar to, but quantitatively different from, the glomerular filtrate is called urine and ultimately enters the bladder. Ever since the discovery that the major, normal constituents

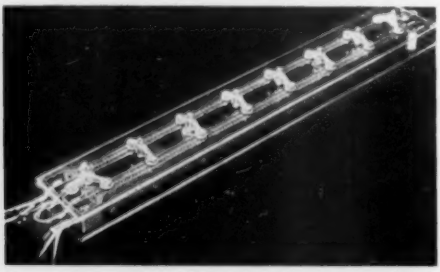


FIG. 4. An assembled 4-channel counterflow hemodialyzer unit using 4,000 sq cm cellophane tubing compressed to a slitted lumen about 1 mm deep. Several units may be used in parallel. Blood volume per unit is 300 ml at 50 mm Hg differential pressure (*15*).

in the urine are derived from the blood by ultrafiltration at the glomerular capsule, there has been a rationale for basing an artificial kidney on the principle of hemodialysis.

The urinary function is complex. A metabolic waste such as urea is merely excreted. There can be no quantity of this material in the blood so small that some is not found in the urine. Glucose, on the other hand, is not usually detected in the urine by ordinary tests unless it is present in abnormally great quantity in the blood, as in certain diabetics. Thus, the kidneys regulate concentrations in body fluids by retention as well as by excretion. In the case of water and ions such as sodium and chloride, the regulatory faculty is highly developed. Sodium, for example, taken in such excess as to elevate the plasma sodium concentration above normal, leads to the excretion of a urine more concentrated in sodium than the concurrent plasma. This output, removing from the plasma relatively more sodium than water, tends to depress the plasma sodium concentration toward normal. If water is taken, diluting the plasma sodium below normal, the renal response is the production of a urine more dilute in sodium than the concurrent plasma. In this case, elimination of relatively more water and less sodium tends to pull the plasma concentration of sodium up toward normal.

In renal disease excretory power is reduced, resulting in an accumulation of materials in the body which should have been eliminated in the urine. Urea, creatinine, uric acid, phenols, guanidine, acids, and potassium are among these materials. Curiously, the regulatory function for other ions such as sodium is not strikingly impaired, and aberrant concentrations of this ion are less commonly seen. Uremia—nausea, vomiting, vertigo, coma, and death—may accompany these retentions, but the substances responsible are not specifically known. Urea and creatinine, for example, are relatively nontoxic. Known or not, offending material is apparently removed from the body readily by hemodialysis, to judge from the prompt alleviation of symptoms following this treatment.

Some renal disabilities appear to be intrinsically temporary since, given time, they disappear. Such impairments are called "reversible." If the kidneys are badly injured by inhalation of carbon tetrachloride fumes, or by mercuric chloride poisoning, renal excretion of toxic metabolites declines. The patient becomes uremic and, for a period, worsens steadily. If he does not run out of time, his kidneys eventually recover sufficient function so that he gets well. Reversible renal dysfunctions are also found following a patient's reaction to the transfusion of blood of the wrong type, following severe burns, and in other conditions. Treated conservatively, such individuals have been known to show spontaneous return of renal function after one, two, or three weeks, or even longer. Conservative treatment aims at preserving the *status quo* of the patient in as many dimensions of regulation as possible, as long as possible, using the usual hospital armamentarium. Although little can be done to

prevent completely, or to reverse, the steady rise of urea or more toxic metabolites in the body fluids in renal failure, the amount of water lost through cutaneous and pulmonary channels can be replaced almost quantitatively, and it is helpful similarly to replace the salt that may be lost in sweat, vomitus, and other excretions. Where acidosis sets in, akalinizing agents may be administered, and so on. Despite careful management, a sudden rise in the plasma concentration of potassium, released from cells that contain it in relatively high concentration, may early snuff out heart action and preclude further recovery.

How can one say that such patients, given time, might have recovered, when in fact they died? Actually the belief in potential reversibility of renal function is strongly supported by observations following hemodialysis. We now know of numerous instances in which conservative treatment has no meaning for survival. Consider a patient approaching terminal uremia: he has been steadily deteriorating, has become moribund, and by sober clinical judgement will probably die in a matter of hours or, at best, days. After several hours of hemodialysis an accumulation of toxic material is removed from his body. Coma becomes consciousness, then alertness. Where there were nausea and vomiting, there are appetite and hunger, and the patient's condition is now as it was perhaps a week previously in the course of his uremia. Or consider a woman, dialytically awakened from what should have been her final sleep, who can effortlessly, skillfully, and promptly lie about her age. If the underlying kidney defect persists, the patient's downhill course is renewed, but there are now several more days available to the recovery processes going on in, or in behalf of, the kidneys. If no renal improvement is manifest, the patient again passes into a highly critical condition, and a second hemodialysis can be performed with effect similar to the first. Even a third run might be considered, but by this time there will usually be some indication as to whether restoration of kidney function is likely.

Some who have observed clinical effects obtained with one or another of the various artificial kidneys will fairly protest these heart-warming clinical pictures. They have seen only indifferent results, or worse. If patients recovered, so much for coincidence. But those who have seen patients slip away and be pulled back once or twice, ultimately to recover, believe that critical, life-saving time is borrowed from hemodialysis. If this therapy is more effective than conservative treatment, one should expect to find a significant increase in the percentage of renal disabilities that ultimately reverse, where hemodialysis is undertaken. A statistical demonstration will have to wait until studies have been made in a larger number of more carefully screened candidates. Whether it is humane for the physician to yield to family pressure to "do everything possible" for the patient whose kidney tissue is almost assuredly irreparably damaged, and for him to bring such patients to the artificial kidney in the hope, but not the expectation, of giving lasting aid, is a moot question. Perhaps valuable information toward future developments is so provided. Nevertheless, there is little doubt that this practice mars the statistical record of hemodialysis. It is natural, meantime, that believers should be more articulate than skeptics, and that controversy as to the merit of this therapy should abound. There are evidences that not all hemodialyzers can provide the hoped-for statistics: On the one hand it seems clear that the dialytic capacity of some machines is less than that of others; but, on the other, there is testimony that indifferent or poor results may accompany "chemical cure."

Chronic renal disease, progressing slowly toward a degree of dysfunction incompatible with life, cannot usually be helped except transiently by the artificial kidney. Yet the sense of well-being that may result improves the prospect of instituting proper medical management which, emphasizing a low protein diet to minimize the production of toxic metabolites, is often effectively palliative (*22*).

Before leaving eristic matters, let us note additional treatments claimed of value in kidney disease. The most important of these are exsanguinotransfusion, or repeated withdrawal of uremic blood followed by replacement with normal blood, and lavage of the abdominal or intestinal cavities (*23*). Whatever their merit, they bring with them new and often trying procedural problems. They are usually less effective per unit time of therapy than hemodialysis, and time may be of the essence. Kolff (*5*) has studied in a man perfusion of a 1-meter intestinal loop, the ends of which were brought through the abdominal wall. Five grams of urea were removed in one 10-hour period. On another occasion (*24*) larger amounts were removed by way of a 2.5-meter loop. Concluding a lecture in 1947 (*25*), Kolff expressed the hope that in time he might see a patient "who is doing his work in the daytime and who is dialyzing himself through his intestinal loop during the night and in whom both kidneys will have been removed as useless, superfluous, and even dangerous organs."

At some point in thinking of uremia one wonders about operatively exchanging diseased kidneys for healthy ones. Even if there were no obstacle to setting up "kidney banks" or obtaining relatives, friends, or others willing to give up one of their own valued emunctories, the transplantation problem is fundamentally formidable. It is not too difficult surgically to autotransplant a kidney—i.e., to dissever it from its given vascular and other connections in an animal and suitably reconneet it in another site, say, in the neck of the same individual. Here it may carry on the urinary function successfully indefinitely. But homotransplants—i.e., transplants from one animal to another of the same species—behave as foreign bodies, provoke tissue reactions, and atrophy in a relatively short time. Such transplants have been found successfully to "take" and function adequately for some months (*26*), but greater success than this is unlikely in the present state of knowledge of tissue types. Heterotransplants—i.e., transplants from one to an-

other species—are even shorter-lived. A goat kidney connected to the circulation of a dog can kill the host promptly. It is supposed that the graded reactions to transplants vary with genetic relationship, antagonism being less the closer the donor's gene totality is to that of the host. If so, transplantation cannot now be considered the therapy of choice, except possibly in the case of identical twins.

"Natural kidney" physiologists frequently use a concept of "clearance." The renal clearance of a substance from the plasma is its rate of excretion per minute per unit plasma concentration. Dimensionally, clearance has the units of ml/min and represents the number of ml of plasma virtually cleared of the substance in one minute. In another way, it is the volume of plasma which contains that quantity of the substance excreted in the urine in one minute. Where the clearance remains constant at varying plasma concentrations, it may indicate that a load of the substance in the body disappears according to the law of exponential decay, much as a lump of radioactive material disintegrates. The kinetically related concept for the artificial kidney is that of "dialysance" (*18, 27*), defined as the net rate of exchange of a substance between blood (plasma) and bath per minute per unit blood-bath concentration gradient. At the beginning of hemodialysis (zero time), if a dialyzable substance is present in the plasma but not in the bath, the dialysance and the dialytic clearance are equal. With time, the dialytic clearance falls off, whereas the dialysance tends to remain constant. Thus, with natural renal excretion at constant clearance, we may speak of the half-life of a load of material; but not so with a bath type of artificial kidney. Here it is the concentration gradient that has a half-life. Table 1, which dilates upon a scheme of comparative nephrology proposed by Kolff (*5*), may be misleading unless this fact is kept in mind.

Moreover, it is not easy to generalize upon the relative excretory efficiencies of artificial and natural kidneys. Comparisons for urea are creditable but do not hint at the fact that in the excretion of a substance such as bromide, the artificial kidney can be distinctly superior to natural kidneys, whereas with *p*-aminohippurate the reverse may be the case. Occasionally a devotee of a bromide-containing proprietary remedy will ingest an amount of bromide causing an appreciable blood level of this material (normally not present except in traces), and bringing on a train of unpleasant or dangerous symptoms. As his natural kidneys view it, the rare and foreign bromide is not very different from the ubiquitous and natural chloride. These two ionic species possess a kind of "congruence" which causes them to be excreted similarly, and therefore competitively, by the natural kidney. This means that the rate of excretion of bromide is only in proportion (which may be small) to its fraction of the total halide, and that the natural bromide clearance is of the same small order of magnitude as that of chloride (1–2 ml/min). The artificial kidney, however, is largely oblivious to ionic mimicry. It permits bromide to be excreted at a rate proportional to its blood-bath gradient which, at zero time at least, implies a rate proportional to its own amount in the body without regard to total halide. And, as might be expected, its dialysance (and dialytic clearance) is large (*28*). In the case of *p*-aminohippurate, natural kidneys couple tubular secretion of this material to its filtration, giving, at least at low plasma concentrations, a natural clearance of some 650 ml plasma/min, which is far in excess of the present operational capacity of artificial kidneys.

Dialysances of different materials vary considerably, presumably reflecting different diffusibilities, permeabilities, and electric charges, among other things. With constant dialyzing surface, dialysances increase with blood flow, but when this is high, they take up relative values more or less characteristic of the particular molecular or ionic species. The ratio of the dialysance of a substance to that of urea measured simultaneously at any given flow is called the relative dialysance. *In vitro* experiments (*18*) at a flow of 500 ml/min have yielded the values shown in Table 2. The remarkable thing is that these hemodialyzers separate not merely colloidal from crystalloidal material but separate the different crystalloidal species. Fuller implications and applications of this phenomenon have yet to be discovered.

One looks to the future of artificial kidneys and hopes they will become smaller in bulk and weight, and still more effective. Some counterflow dialyzers (Figs. 3, 4) are at present quite small, but they remain with an irreducible bulk of dialysis fluid (and container) necessary to effect a desired degree of solute exchange in a given time, not to mention the bulk of thermostats and other appurtenances. It seems logical to advocate that increases be made in the dialyzing surface, the membrane permeability, and the blood flow in future hemodialyzers to improve their efficiency. Yet he who attempts to implement these disarmingly simple suggestions—incorporating the other desiderata as well—must live with some obstinate if not ineluctable facts of physiological engineering. Of course, some entirely different principle than differential dialysis for artificial kidneys may eventually be exploited; exchange resins have been tested (*29*), for example. This is the more credible inasmuch as natural kidneys do not themselves use the hemodialytic principle described here, so far as we know. In any event, it improves one's perspective to remember that the artificial kidney is merely another of the multifarious products of an engineering that gives us artificial eyes, teeth, breasts, limbs, and brains. The prosthetists are busy even now polishing their artificial heart valves, and it is not so difficult (for those who are not biochemists) to envisage the day of the factitious liver.

References

1. ABEL, J. J., ROWNTREE, L. G., and TURNER, B. B. *Trans. Acad. Am. Physicians*, **28**, 51 (1913).
2. ———. *J. Pharmacol. Exptl. Therap.*, **5**, 275 (1914).
3. ———. *Ibid.*, 611.

4. Kolff, W. J., and Berk, H. Th. J. *Acta Med. Scand.*, **117**, 121 (1944).
5. Kolff, W. J. *New Ways of Treating Uraemia*. London: Churchill (1947).
6. Murray, G., Delorme, E., and Thomas, N. *Arch. Surg.*, **55**, 505 (1947).
7. Alwall, N. *Acta Med. Scand.*, **128**, 317 (1947).
8. ———. *Ibid.*, **133**, (Suppl. 229), 20, 22, 30 (1949).
9. Skeggs, L. T., Jr., and Leonards, J. R. *Science*, **108**, 212 (1948).
10. Skeggs, L. T., Jr., Leonards, J. R., and Heisler, C. R. *Proc. Soc. Exptl. Biol. Med.*, **72**, 539 (1949).
11. Sterling, J. A., and Doane, J. C. *Urol. and Cutaneous Rev.*, **53**, 385 (1949).
12. Vanatta, J., Muirhead, E. E., and Grollman, A. *Am. J. Physiol.*, **156**, 443 (1949).
13. Merrill, J. P., *et al. J. Clin. Invest.*, **29**, 412 (1950).
14. Merrill, J. P., *et al. Ibid.*, 425.
15. Rosenak, S. S., and Saltzman, A. *Proc. Soc. Exptl. Biol. Med.*, **76**, 471 (1951).
16. Lowsley, O. S., and Kirwin, T. J. *J. Urol.*, **65**, 163 (1951).
17. Merrill, J. P. *New Engl. J. Med.*, **246**, 17 (1952).
18. Wolf, A. V., *et al. J. Clin. Invest.*, **30**, 1062 (1951).
19. Wolf, A. V. *The Urinary Function of the Kidney*. New York: Grune & Stratton (1950).
20. Leonards, J. R., Skeggs, L. T., Jr., and Kahn, J. R. *Federation Proc.*, **10**, 214 (1951).
21. Wolf, A. V., Kiley, J. E., and Currie, G. D. *Ibid.*, 148.
22. Merrill, J. P. *Ann. Internal Med.*, **33**, 100 (1950).
23. Snapper, I. *Bull. N. Y. Acad. Med.*, **25**, 199 (1948).
24. Twiss, E. E., and Kolff, W. J. *J. Am. Med. Assoc.*, **146**, 1019 (1951).
25. Kolff, W. J. *J. Mt. Sinai Hosp. N. Y.*, **14**, 71 (1947).
26. Lawler, R. H., *et al. J. Am. Med. Assoc.*, **144**, 844 (1950); *ibid.*, **147**, 45 (1951).
27. Wolf, A. V., *et al. J. Clin. Invest.*, **30**, 683 (1951).
28. Merrill, J. P. Personal communication.
29. Muirhead, E. E., and Reid, A. F. *J. Lab. Clin. Med.*, **33**, 841 (1948).

News and Notes

University of Illinois Conference on Physics of Ionic Crystals

About 70 physicists and physical chemists met at the University of Illinois Oct. 29–30 to discuss recent developments in research on the thermal, electrical, and optical properties of ionic crystals. Occasioned by the presence in this country of Robert W. Pohl, of the University of Göttingen, pioneer investigator in this field, and sponsored by the University of Illinois in cooperation with the Office of Naval Research, the conference was under the joint chairmanship of F. Seitz and R. J. Maurer. The formal program consisted of 19 invited papers, primarily on the alkali halides, of which about one third were theoretical in nature.

There seem to be two main reasons for the current interest in ionic crystals, particularly the alkali halides: (1) Many types of electrical, optical, and thermal measurements can be made on ionic crystals that cannot be performed, for example, on the more obviously interesting metals, but which nevertheless are related to phenomena occurring in all crystals. (2) The general properties of the alkali halides are probably better understood than are those of most other solids, so that new effects can be isolated and interpreted with relatively great confidence in the alkali halides and then generalized and applied to other crystals. For example, the effects of crystal imperfections, such as dislocations, vacancies, and impurities, are of first-order importance in the strength of structural materials, and these imperfections can be investigated in the alkali halides by a number of methods not available for metals.

One of the best ways of obtaining information about vacancies is through study of *F*-centers in the alkali halides. The *F*-center, almost certainly consisting of an electron trapped in a negative ion vacancy, is perhaps the most thoroughly investigated phenomenon in ionic crystals. Nevertheless, new experiments continue to be performed, and many new and significant data were presented on this subject. Burstein (NRL) described experiments demonstrating the effects of temperature and pressure in the width and position of the *F*-band in KCl, and showed that the results were in qualitative agreement with the simple particle-in-a-box model for the *F*-center. Scott (Oregon State College) discussed experiments on the optical and thermal coagulation of *F*-centers into larger aggregates, and determined activation energies for these processes.

Dutton and Maurer (University of Illinois) described electrical and optical measurements on KCl crystals which were allowed to heat up slowly from low temperatures. Associated with the disappearance of the V_1 absorption band and a diminution of the *F* and *F'* bands, they observed a large burst of thermally released charge and a flash of luminescence. These experiments indicate that positive holes are thermally released from positive ion vacancies at about −130° C, wander to *F*-centers, and combine optically with the *F*-center electrons. When KCl crystals were irradiated with x-rays at liquid He temperatures, negligible production of *F'*-centers was observed, but there was normal darkenability in the *F*-band. This is somewhat surprising, since one expects a totally negligible number of isolated vacancies at these temperatures and insufficient thermal energy for appreciable diffusion of ions or vacancies. Markham and Duerig (Johns Hopkins Applied Physics Laboratory) also observed this large darkenability by x-rays at He temperatures, and it seems necessary to infer that the local heating arising from absorption of an x-ray photon is sufficient to allow the diffusion of vacancies. These experiments point out the extreme desirability of investigations designed to create *F*-centers at He temperatures by the relatively gentle means of irradiating in the tail of the first fundamental band. According to current ideas, the only negative ion vacancies present at He temperatures should be attached to dislocations

(incipient negative ion vacancies) or aggregated with positive ion vacancies into clusters. At these temperatures it should be impossible either for the incipient vacancies to diffuse away, or for the clusters to dissociate. Thus, one would expect to produce new absorption bands by the creation and subsequent ionization of excitons. If the same F-band is produced under these conditions as at high temperatures by additive coloration, when one is certain the vacancies are isolated, revision of some of our present beliefs is almost inevitable. And if new bands are produced, we can perhaps get information about dislocations from them.

Markham and Duerig also discussed the impurity content of alkali halides obtained from various sources, and some correlations among changes in the F-, F'-, and V-bands. Other correlations between pairs of absorption bands have led Pringsheim, Yuster, and Delbecq (Argonne National Laboratory) to propose models for their α- and β-centers in KI. The α- and β-absorption bands in the ultraviolet, they suggest, are a result of optical transitions of the valence electrons of the halide ions in the vicinity of negative ion vacancies and F-centers, respectively. They also find that F-centers are not created upon irradiation in the α-band at low temperatures. If substantiated by further investigation this fact will require interpretation, inasmuch as Smakula found he could create F-centers by irradiating in the tail of the first fundamental band in KBr at liquid air or higher temperatures.

Pohl presented recent data from Göttingen on some other ultraviolet absorption bands in KBr (the U- and U'-bands) and described some of the transitions involving these bands, particularly at low temperatures. The U-band has been believed to correspond to optical transitions of impurity hydride ions, but perhaps this model should be reinvestigated in the light of recent results. Pohl also reviewed recent work on the ionic conductivity in alkali halides, particularly as influenced by the presence of divalent positive ion impurities and their associated positive ion vacancies. Lawson (University of Chicago) discussed the ionic conductivity of AgBr at high temperatures and pressures, but he was particularly interested in the evidence for the presence of Schottky-type defects in the silver halides. He concluded that both Frenkel and Schottky defects may be present in appreciable quantity at high temperatures.

Seitz discussed an ingenious experiment described to him in private correspondence from Ueta at the University of Kyoto in Japan. The M-center, according to Seitz' model, consists of a cluster of two negative ion vacancies, a positive ion vacancy, and an electron, and hence possesses noncubic symmetry. Ueta performed bleaching experiments by irradiating the KCl crystal in the M-band with light polarized in various directions; his results were in agreement with the symmetry of Seitz' model.

Several papers were presented on crystals other than the pure alkali halides. Krumhansl (Cornell University) described some cellular calculations on BaO by the method of Ewing and Seitz, showed that it is 80% or 90% ionic in nature, and discussed its energy bands. Sproull described the recent work at Cornell on photoconductivity and light absorption measurements in BaO, and Eisenstein (University of Missouri) discussed his experiments on the luminescence of BaO and suggested an energy level diagram. Williams (G-E Research Laboratories) presented his calculations on the positions and widths of the absorption and emission bands in Tl activated KCl phosphors, and described some transitions between excited states of the Tl^+ ion. Shulman, Etzel, and Ginther (NRL) presented data on x-ray–induced color centers in silver activated alkali halides, and Smakula (Engineering Research and Development Laboratories) discussed measurements on color centers in CaF_2 and quartz.

Two papers were concerned with the formation and propagation of excitons in insulating crystals, but from slightly different points of view. Brooks (Harvard University) presented some calculations on a generalization of the exciton model first proposed by Wannier and later discussed by Slater. This type of treatment offers great promise for the solution of problems involving electrons in perturbed periodic fields, particularly in crystals of high dielectric constant. Heller (University of Illinois) discussed excitons on the basis of the Frenkel-Peierls model, with particular reference to their effective mass and their relevance to the Lorentz "local field."

In the writer's opinion, one of the most interesting questions that can be asked about ionic crystals, or other insulators, is the following: What happens to the electromagnetic energy one puts into the crystal as a result of absorption in an exciton band? That is, what happens to the excitons? Certainly, the interaction with lattice vibrations is of the greatest importance, for without the incoherence introduced by photons, the lifetime against radiation becomes negligible even compared with nuclear vibration times, and yet appreciable luminescence is almost never observed in reasonably pure crystals. Recent experiments by Apker and Taft (G-E Research Laboratories) have helped to shed some light on this question in the alkali halides. Their measurements on the external photoelectric effect have shown that, at least in their imperfect, evaporated layers, excitons can both create and destroy F-centers with high probability. Apker, Taft, and Hebb (G-E) have also found strong dependence on surface properties, even to the point where one may speak of a surface "dead layer" of about 10^{-6} cm in which excitons are destroyed without contributing to external photocurrent. They have also observed strong surface effects in the edge luminescence of CdS. Apker and Taft presented evidence here on the effects of the β-centers in their photoelectric measurements, and Hebb discussed calculations on the interpretation of the energy distribution of the external photoelectrons. Dexter (University of Illinois) described some specific mechanisms for excitons both to create and destroy F-centers and

showed that the probabilities for these processes are indeed very large, and that they may well compete favorably with luminescence even in relatively perfect crystals.

With this small group it was possible for most of those present to engage in active discussion between the formal papers. Also, the several social gatherings and intermissions encouraged informal conversations that helped make the conference of particular value to the participants.

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Scientists in the News

Carl E. E. Bunn has been appointed staff veterinarian at Sharp & Dohme. He has been serving as veterinary inspector with the U. S. Department of Agriculture in Philadelphia.

Kenneth W. Chapman has been appointed medical officer in charge of the U. S. Public Health Service Hospital, Lexington, Ky. Dr. Chapman succeeds **Victor H. Vogel,** who has been assigned to the American Embassy in Paris as medical officer in charge, USPHS, Foreign Quarantine activities.

George O. Curme, Jr., has been elected a director of Union Carbide and Carbon Corporation to succeed the late **James A. Rafferty,** vice president and director. Dr. Curme, as vice president, is in charge of all research activities of the corporation.

José Manuel Rodriguez Delgado, research fellow in physiology at the Yale School of Medicine, has been awarded the 1952 Ramon y Cajal Prize—the highest scientific award given by the Spanish government. Dr. Delgado, who has been on leave from the University of Madrid since 1950 to work at Yale, won the prize for his paper on a new technique for brain study. The Ramon y Cajal Prize, which carries an honorarium of about $1000, was established in honor of the late Santiago Ramon y Cajal, for Spanish scientists, who must submit papers on original research conducted during the year. Dr. Delgado, a native of Rondo, Spain, received his medical training at the University of Madrid and has been on the faculty there since receiving his medical degree. He also is a member of the Cajal Institute, which is associated with the university and devoted to scientific research.

James P. Growdon, chief hydraulic engineer for Aluminum Company of America since 1938, has been named engineering consultant on hydraulic and related engineering problems. **B. J. Fletcher,** assistant chief hydraulic engineer, will succeed Mr. Growdon as chief hydraulic engineer. Mr. Growdon joined ALCOA in 1925 as assistant hydraulic engineer. Mr. Fletcher began with the company in 1926 and, after serving as a designer and structural engineer, was made chief engineer of the company's development division in 1944.

F. F. Hill has succeeded **Cornelis W. de Kiewiet** as provost of Cornell University. An authority on land economics, Dr. Hill has been a member of the Cornell faculty since 1930 and chairman of the Department of Agricultural Economics since 1943.

Vaclav Hlavaty, professor of mathematics at Indiana University, has been appointed to the staff of the Graduate Institute for Applied Mathematics.

Robert B. Howard has been named director of continuation medical education at the University of Minnesota. He succeeds **George N. Aagaard,** who has taken over his new duties as dean of Southwestern Medical School, Dallas, Texas.

William D. Johnston, Jr., chief of the Foreign Geology Branch of the U. S. Geological Survey, and **Martin J. Buerger,** professor of mineralogy and crystallography at MIT, have been elected foreign members of the Brazilian Academy of Sciences.

Clark Kerr, economist and arbitrator of labor-management disputes, has been elected chancellor for the Berkeley campus of the University of California. Dr. Kerr joined the faculty in 1945 to organize an Institute of Industrial Relations, of which he has since been head. Partly as a result of the dispute over the loyalty oath, the faculty has been insistent that one of its number be elected to the Berkeley chancellorship. During the controversy Dr. Kerr served on the committee on privilege and tenure of the Academic Senate, which reviewed the cases of professors who refused to sign the special loyalty statement, and recommended retention of most of them.

George A. Kiersch, formerly supervising geologist for the International Boundary and Water Commission at Alpine, Texas, has accepted appointment as assistant professor of geology at the University of Arizona.

Directors of the Houdry Process Corporation have elected **Chalmer G. Kirkbride** president and **Claude C. Peavy** vice chairman of the board. **Clarence H. Thayer,** vice president in charge of manufacturing of the Sun Oil Company, was elected a director. Mr. Kirkbride, formerly vice president in charge of research and development, and Dr. Peavy, vice president in charge of engineering and sales, both joined Houdry in 1946.

George H. M. Lawrence, professor of botany at Cornell University, has been appointed director of Cornell's Bailey Hortorium, succeeding **Liberty Hyde Bailey,** who established the Hortorium and gave it to the university in 1935. Dr. Bailey has resigned as director but will continue in an advisory capacity. Dr. Lawrence has been on the Cornell staff since 1938.

For the first time in its 45-year history, the American Chemical Society's St. Louis section has elected

a woman chairman, **Ree S. Le Beau,** director of research of the Midwest Rubber Reclaiming Company, East St. Louis. She succeeds **Joseph R. Darby,** a group leader in the research department of the Monsanto Chemical Company. Dr. Le Beau also holds the distinction of being the first woman to serve as chairman of one of the society's 20 scientific and technical divisions. She was chairman of the Division of Colloid Chemistry in 1949, and has been chosen to serve as its chairman again in 1953. Other officers of the St. Louis section for 1952 are: chairman-elect, **William H. Elliott,** senior instructor in biological chemistry at St. Louis University; secretary, **Roger W. Stoughton,** research chemist at the Mallinckrodt Chemical Works; and treasurer, **Hal G. Johnson,** assistant director of Monsanto's general development department.

James McCormack, Jr., has been named director of nuclear applications, Office of the Deputy for Development, Headquarters, Air Research and Development Command. General McCormack recently received the Distinguished Service Medal for his services as director, Military Applications Division, AEC, from 1947 to 1951. **Robert N. Isbell,** who has been serving as director of nuclear applications, will serve as deputy director to General McCormack.

William C. Moloney, clinical professor of medicine, Tufts Medical School, will leave with his family for Hiroshima, Apr. 1. He will serve for the next two years as internist with field units of the Atomic Bomb Casualty Commission which are engaged in a study of the effects of atomic radiation in Hiroshima and Nagasaki. The work is under the direction of the National Research Council and the National Academy of Sciences.

Two Brazilian educational institutions have honored **Linus Pauling,** chairman of the Division of Chemistry and Chemical Engineering at California Institute of Technology, for his contributions to modern chemistry. The analytical chemistry research center of the University of Recife School of Pharmacy has been named the "Linus Pauling Study Center," and Dr. Pauling has been elected an honorary member of Emil Fischer Study Center in Pernambuco, the first non-Brazilian to be so honored.

Eugene L. Perrine has been appointed senior physicist for the Zonolite Company, Chicago. He will assist **George E. Ziegler,** director of research, in fundamental and applied research dealing with vermiculite, which is produced by Zonolite. For the past five years, Mr. Perrine has been a member of the physics research department at Armour Research Foundation.

John T. Rettaliata, vice president and dean of engineering at Illinois Institute of Technology, has been named president of the institute. He succeeds **Henry T. Heald,** who has become chancellor of New York University. Dr. Rettaliata also was appointed president of Armour Research Foundation and of the Institute of Gas Technology. He has been vice president in charge of academic affairs at the institute since 1950 and dean of engineering since 1948. He joined the staff in 1945 as director of the Department of Mechanical Engineering.

The 1951 Marie-Victorin medal, which is awarded annually to a botanist who has done extensive work on Canadian flora, has been given to **Jacques Rousseau,** director, Montreal Botanical Garden. M. Rousseau conducted a survey of northeastern Ungava and Labrador, crossing the peninsula through the Adloylik Fjord and the Korok River. He also surveyed the Chubb Crater in northwestern Ungava.

William Saphir has been appointed clinical assistant professor of medicine at the University of Illinois. Dr. Saphir, a graduate of the Medical School of the University of Vienna, is a member of the attending staff at Cook County, Michael Reese, and Chicago Memorial hospitals in Chicago.

Henry William Scott, Jr., associate professor of surgery at Johns Hopkins Hospital, has been appointed professor of surgery at Vanderbilt Medical School and surgeon in chief to the Vanderbilt Hospital, succeeding **Barney Brooks.** Dr. Brooks, who will become professor emeritus of surgery, will remain in Nashville and continue to be affiliated with Vanderbilt.

As distinguished lecturer for the American Association of Petroleum Geologists, **Edmund M. Spieker,** chairman of the Department of Geology at Ohio State University, has spent the months of January and February lecturing on "Mountain-Building Chronology and the Nature of the Geologic Time Scale." Dr. Spieker's itinerary has taken him to universities, regional AAPG sections, and local geological societies from Massachusetts to California, and from Ontario to Louisiana.

Memorial Center for Cancer and Allied Diseases has named **Richard D. Vanderwarker** administrative director. He has been director of the Passavant Memorial Hospital in Chicago, associate director and lecturer in hospital administration in Northwestern University, and consultant to the editorial board of *Modern Hospital Magazine.*

Isaac D. Welt has been appointed assistant director and principal scientist of the Radioisotope Unit, VA Hospital, Houston, and assistant professor of biochemistry at Baylor University College of Medicine. Dr. Welt was formerly on the staff of the Division of Nutrition and Physiology of the Public Health Research Institute of the City of New York, Inc.

Charles W. Williams, coordinator of research at Case Institute of Technology, is now special assistant to the president of Case, and **Ray E. Bolz,** associate professor of aeronautical engineering, has become his successor in the post of coordinator. Dr. Bolz will continue to supervise activities at Case in the field of aeronautical engineering and will do a limited amount of teaching.

Education

A short course on soap and synthetic detergents will be sponsored by the **American Oil Chemists' Society** at Rutgers University, July 6–11, with Foster D. Snell as chairman. Enrollment will be limited to 200, and the fee for registration, room, and board will be $90. Applications should be sent to the society at 35 E. Wacker Dr., Chicago 1.

The Department of Preventive Medicine at the **University of Illinois College of Medicine** has been merged with the Department of Medicine. It is probable that a Division of Preventive Medicine will be created in the department. The College of Medicine has promoted Stanley W. Olson to assistant professor of physiology and Harry M. Segenreich to clinical assistant professor of psychiatry.

The summer quarter of the **Interamerican School of Spanish** at Saltillo, Coahuila, July 7–Aug. 22, offers the M.A. in Spanish language and literature and in Mexican culture. Credits are accepted in U. S. and Canadian universities. Other subjects offered are in Mexican art, Gregg shorthand (Spanish), and methods of teaching Spanish. U. S. registrar is Donald M. Custer, Box 413, Salida, Colo.

The **University of Michigan** has acquired a 267-acre site across the Huron River and northeast of Ann Arbor, where immediate plans call for the construction of two research laboratories, the Cooley Memorial and the Phoenix Memorial, at a total cost of nearly $2,000,000. In addition it is hoped to build a library stack unit to house books not in everyday use and an $800,000 automotive laboratory, which would permit the removal of the West Engineering Annex to the new site.

In the Laboratories

Eli Lilly has appointed G. B. Walden vice president, in which post he will be head of biochemical manufacturing. J. C. Siegesmund has been made vice president of engineering, replacing W. A. Hanley, who retired Dec. 31.

John B. Lathrop, a mathematician specializing in military operations research techniques, has joined the operations research group of **Arthur D. Little.** Aileen Merwin, nutritionist, has also joined the staff. Her work will be principally with the Food and Flavor Group.

Sharp & Dohme opened its new $500,000 pharmaceutical manufacturing laboratories in Manila with Elpidio Quirino, President of the Philippines, as principal speaker. In the Caribbean, Albert E. Ibarguen, general manager in that area for Sharp & Dohme Inter-American Corporation, has been appointed to the newly created position of district manager of export field operations. As such he will make his headquarters in Philadelphia and will be responsible for Puerto Rico, the Caribbean (except Cuba), as well as Argentina, Venezuela, Uruguay, Paraguay, and all Central American countries.

Southwest Research Institute has appointed the following specialists to its staff for work in the field of engineering mechanics: Arthur W. Dickson, formerly with Du Pont; Joseph D. Domine, of Geovision, Inc.; Herbert I. Hoffman, mechanical engineer; William P. Murden, Jr., of Virginia Polytechnic; Asa L. Pierce; Grady M. Slagle, of Douglas Aircraft; William P. Teich, statistical analyst; and L. E. Wilson, who was with Curtiss-Wright and Consolidated Vultee.

U. S. Rubber Company has made L. C. Boos vice president and general manager of United States Rubber International, which will replace the present foreign subsidiary. Headquarters of the new division are being moved to the Chrysler Building.

Miscellaneous

The **Institute for the Unity of Science** is offering a prize of $500 for the best essay on "Mathematical Logic as a Tool of Analysis; Its Uses and Achievements in the Sciences and Philosophy" and two prizes of $200 each for the two next best essays. Manuscripts must not exceed 25,000 words, may be written in English, French, or German, and must be submitted before *Jan. 1, 1953.* For further information address the institute, American Academy of Arts and Sciences, 28 Newbury St., Boston 16.

The **Instrument Society of America** has recently established new technical committees on Medical and Biological, Meteorological, Radiation, and Geophysical Instrumentation, and Physical Properties Measurement, in order to broaden the scope of its program and encompass a large number of specific fields. Contributed papers on these topics will be accepted for presentation at the seventh annual National Instrument Conference and Exhibit to be held in Cleveland Sept. 8–12. Emphasizing that instrumentation is the common denominator of all the physical sciences, the ISA invites scientists and engineers to attend and participate in the conference and exhibit. Complete information on programs, membership, and committees may be obtained from the national office at 1319 Allegheny Ave., Pittsburgh 33, or from the vice president, W. A. Wildhack, National Bureau of Standards, Washington 25, D. C.

At the dedication of the **Liberian Institute** of the American Foundation for Tropical Medicine James S. Simmons, USA (ret.), dean of the Harvard School of Public Health, gave an address, as did Harvey S. Firestone, Jr., W. V. S. Tubman, and Joseph N. Togba, 1949 Harvard graduate who is now Liberian director of public health and sanitation.

The **National Chemical Exposition** has named Gustav Egloff honorary chairman of the second International Art Exhibit to be held as part of the exposition Sept. 9–13, in Chicago. Limited to the work of chemists,

the exhibit is open to work in oils, tempera, water colors, drawings, and prints, and each exhibitor may enter two works. Entry cards may be obtained from the National Chemical Exposition, 86 E. Randolph St., Chicago 1.

New journals recently received include: *Lore,* Vol. 1, No. 4, Fall issue. Published quarterly by the Milwaukee Public Museum. Obtainable only through membership. . . . *Notiziario dell' Istituto Vaccinogeno Antitubercolare,* Vol. 1, No. 2, April–June 1951. Milan. 1,000 lire per year. . . . *Our Public Lands,* Vol. 1, No. 3, October 1951. Issued quarterly by the U. S. Department of the Interior Bureau of Land Management. . . . *Revista Cientifica,* Vol. 1, No. 2. Available on an exchange basis to universities, scientific societies, research institutions, industrial firms, and scientific publishers. Address Faculdade Nacional de Filosofia, Av. Presidente Antonio Carlos, 40–6°, Rio de Janeiro. . . . *The Science Reports of the Research Institutes,* Vols. 1, 2, No. 1, January 1951. Tohoku University, Sendai, Japan. In four series: A, Physics, Chemistry, and Metallurgy; B, Technology; C, Medicine; and D, Agriculture, all in English. . . . *Shikoku Acta Medica,* Vol. 1, No. 1. Shikoku Medical Association, Tokushima, Japan. Bimonthly, English and Japanese. . . . *The Summary,* Vol. 2, No. 1, May 1950. Formerly *The Seminar.* Published by The Shute Foundation for Medical Research, London, Canada. . . . *Yokohama Medical Bulletin,* Vol. 1, No. 1, October 1950. English. Yokohama University School of Medicine.

The **New York Academy of Sciences** elected 99 scientists to membership at its annual meeting in January. Albert Caquot, president-elect of the International Academy of France; Henrique da Rocha Lima, director emeritus of the Biological Institute, São Paulo; and Wilhelm Schmidt, director of the Anthropos Institut, Switzerland, were elected honorary life members. George B. Pegram was elected president; John R. Dunning and Paul Fejos, vice presidents; John Tee-Van and Junius B. Bird, secretaries; and Donald M. Benjamin, treasurer. A. Cressy Morrison prizes in natural science were awarded to Karl Maramorosch, for a paper on the aster yellows virus, and to William P. Jacobs, for a paper on hormone control of water-carrying cells in plants.

The **Saskatchewan Geological Society,** organized last year (SCIENCE, **114,** 682 [1951]), has elected Robert A. Bishop president, Harold C. Morrow vice president, and Herbert F. Dodson secretary-treasurer.

British Commonwealth News

H. J. Brown, dean of the Faculty of Engineering, New South Wales University of Technology, has been appointed controller of the research and development branch of the Department of Supply, Commonwealth of Australia. He will be stationed at the Woomera Rocket Range. Professor Brown was formerly principal research officer in the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization.

The **British Commonwealth of Nations Scientific Liaison Office** has recently completed the compilation of graduate scholarships available within the commonwealth for scientific study. Information on 350 entries, many of them covering several scholarships, has been included in a booklet, *The Commonwealth Post-Graduate Scholarships in Science,* published by H. M. Stationery Office.

The Third Annual Report of the **Commonwealth Scientific and Industrial Research Organization** for July 1, 1950–June 30, 1951, surveys a year's progress over a wide range of pure and applied research. Australian economy is reflected in the emphasis that CSIRO gives to plant and animal breeding and pathology, and particularly to all aspects of sheep-raising and wool production. One section of the report recounts the results of experiments with myxomatosis, a virus disease which, it is hoped, may control or exterminate Australia's foremost pest, the rabbit. Another Commonwealth problem is evident from the attention given to research that may alleviate or counter the effect of drought in a country dependent on agricultural and pastoral pursuits.

The **Forest Products Research Board** of the Department of Scientific and Industrial Research has recently issued its report for 1949, detailing research in progress on forests, wood, wood products, mycology, and insect control.

O. E. Lowenstein, senior lecturer in zoology at The University, Glasgow, has been appointed Mason professor of zoology at the University of Birmingham, where he succeeds P. B. Medawar.

The **Medical Research Council** has recently released a general report for 1948–50 and a special report on a five-year investigation of catarrhal jaundice. The general report discusses, among other medical matters that are the subjects of research, progress in the treatment of tuberculosis and rheumatoid arthritis, the relation between smoking and lung cancer, the incidence of poliomyelitis, and undernutrition.

The **Ministry of Supply Atomic Research Establishment,** at Harwell, has installed a central heating plant that will draw its heat from BEPO, the large experimental atom pile. Installed at a cost of £15,000, the system will initially heat a building containing 80 offices, approximately 330,000 cubic feet. It is planned to expand the system, which now has an output of 1,000,000 BTU, to an output of 7,000,000 BTU, and to heat two, or possibly three more buildings. Current savings in coal consumption are estimated at 1,000 tons a year, costing £2,650.

The **Nature Conservancy** has established the first national nature reserve in Britain, by purchasing 10,450 acres in the forest of Kinlochewe in the County of Ross and Cromarty.

Technical Papers

Lack of Inhibition of Growth of *Euglena gracilis* by Vitamin B_{12} Oxidation Product

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In a recent publication Beiler *et al.* (*1*) observed that vitamin B_{12}, when treated with strong acid and hydrogen peroxide, showed a competitive antagonism to vitamin B_{12} when assayed with *Lactobacillus leichmanii* 4797.

It seemed to us of interest to know if the same properties would be exhibited when *Euglena gracilis* is used as a test organism. *E. gracilis* has been proposed for the assay of vitamin B_{12} by Hutner *et al.* (*2*) for its specific response to this vitamin, thymidine and other ribosides being ineffective as substitutes for B_{12} for growth (*3*).

We used in our experiments the culture of *E. gracilis* and the basal medium of Hutner (*2*) slightly modified.[2] In some cases ascorbic acid was added to the medium in the amount of 200 mg/l for the purpose of stabilizing B_{12}, as reported by Hendlin and Soars (*4*). We substituted sodium acetate for sodium butyrate as suggested by Robbins *et al.* (*3*), and the growth curves obtained were perfectly comparable.

The results, presented in Table 1, showed that the

TABLE 1

EFFECT OF THE B_{12} OXIDATION PRODUCT ON THE GROWTH OF *Euglena gracilis*

Vitamin B_{12} (μg/10 ml)	Oxidation product					
	0.00	0.01	0.1	1.0	10.0	50.0
0.0000	0.65	—	—	—	—	—
0.0001	1.90	2.10	1.90	2.05	1.00	1.05
0.001	3.00	—	2.85	1.85	1.00	1.10

B_{12} oxidation product, prepared according to Beiler *et al.* (*1*), was unable to inhibit the growth of *E. gracilis* in a medium containing vitamin B_{12} in a concentration which supports full growth—i.e., 0.001–0.0001 μg/10 ml of the basal medium and the oxidation product in increasing amounts up to 50 μg/10 ml. All the results are expressed in optical density ×10 obtained with a Lumetron colorimeter equipped with a 420-μ filter, which was set at zero with the medium.

Our results indicate clearly that for *E. gracilis* the B_{12} oxidation product is not a competitive antagonist of vitamin B_{12}.

[1] We wish to express our thanks to Randolph T. Major, scientific director of Merck & Co., Inc., Rahway, N. J., for the generous supply of vitamin B_{12} used in these experiments.

[2] The basal medium is of the following composition: $NH_4H_2PO_4$, 0.8 g; citric acid monohidrate, 0.13 g; KCl, 0.14 g; $MgSO_4$ (7 H_2O), 0.20 g; sodium acetate, 1.5 g; disodium glutamate, 1.0 g; $CaCl_2$, 0.1 g; $FeSO_4$ (7 H_2O), 20 mg; $MnSo_4$, 6 mg; $CoSO_4$ (7 H_2O), 5 mg; $ZnCl_2$, 0.8 mg; $Cu\ SO_4$ (5 H_2O), 80 μg; thiamine hydrochloride, 100 μg dissolved in 1 liter of distilled water; pH adjusted to 6.5 with 10% NaOH.

References

1. BEILER, J. M., MOSS, J. N., and MARTIN, G. J. *Science*, **114**, 122 (1951).
2. HUTNER, S. H., *et al. Proc. Soc. Exptl. Biol. Med.*, **70**, 118 (1949).
3. ROBBINS, W. J., HERVEY, A., and STEBBINS, M. E. *Bull. Torrey Botan. Club*, **77**, 423 (1950).
4. HENDLIN, D., and SOARS, M. H. *J. Biol. Chem.*, **188**, 603 (1951).

Manuscript received September 27, 1951.

Thiamin and the Growth Substances for *Phytophthora* in the Bark of Citrus Trees

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Parasitic fungi of cultivated plants are often deficient in their capacity to synthesize substances necessary for their growth, such as the B vitamins. These substances must be present in the medium in which the fungi are cultivated. The chief interest of these studies, from a pathological viewpoint, is that the host must supply the growth substances to the parasite. This may explain problems of parasitic specialization, host resistance, and periodic phenomena of infection and of extension of the parasite in the host.

Foot-rot of citrus, a type of gummosis, caused by several species of *Phytophthora*, is one of the most important diseases of the sweet orange (*Citrus sinensis* Osb.) in São Paulo and other citrus regions of the world. Robbins (*1*) has shown that thiamin is required for the growth of several species of this genus on synthetic media.

Bitancourt and Rossetti have shown (*2*) that in auxanographic experiments thiamin does not affect the radial growth of thalli of *Phytophthora* but rather the ramification of hyphae, thus increasing the thickness of the mycelial mat. A rough measure of the thickness is given by the amount of light passing through the thallus and received on a selenium photocell, the current of which is given by the deflections of a galvanometer. To account for the growth of thalli in diameter, the writers have postulated a hypothetical factor *L*, present in several natural media, as necessary for the growth of *Phytophthora* (*3*).

The auxanographic method lends itself conveniently to indication of the amount of factor *L* and of thiamin—or of substances producing the effect of thiamin

[1] The writers are indebted to Mirjam Kuczynska for technical assistance.

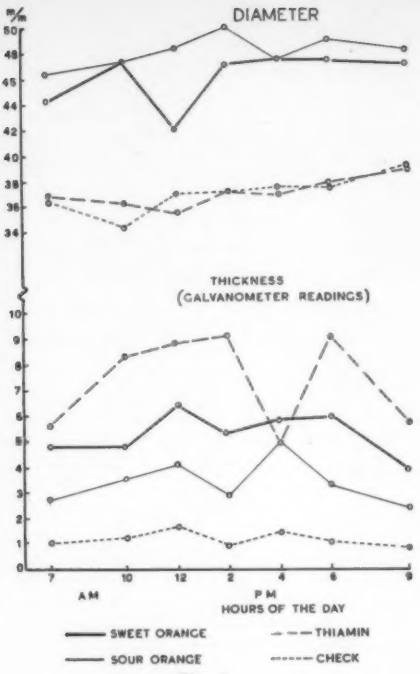

FIG. 1

on *Phytophthora*—in living plant material. Disks of the tissues, such as the bark of citrus trees, 5 mm in diameter, are detached aseptically and placed on the surface of a water-agar or Czapek-agar medium in Petri dishes. The disk is removed after 4 hr, and the place is inoculated with *Phytophthora*. Ordinary agar (*Gelidium*) contains factor *L*, but its effect is slight at the concentration of 2% used in these experiments. In 4%, and especially in 6%, water-agar, *Phytophthora* in 3 days produces thalli made up of extremely sparse hyphae, up to a diameter of 4 cm.

Using this method, the thalli obtained with the bark of sweet orange, a susceptible species, were slightly but significantly larger than those of sour orange (*C. aurantium* L.), a highly resistant species. The thalli obtained with Coronel, a highly susceptible variety of sweet orange, were larger than those of the Pera variety which is rather resistant (*4*).

In the following experiment the effect of both factor *L* (diam of thalli) and thiamin (thickness of mycelial mat as indicated by galvanometer readings) was measured. Disks of bark of 5 sweet orange trees and 5 sour orange trees were detached aseptically with a cork-borer at 7:00, 10:00, and 12:00 A.M. and at 2:00, 4:00, 6:00, and 9:00 P.M. Large, 15-cm Petri dishes, containing 2% Czapek agar, received one disk of sweet orange bark, one of sour orange bark, and one of filter paper containing 0.4 μg thiamin. After 4 hr the disks were removed, and the corresponding place was inoculated with *C. citrophthora* (Sm. & Sm.) Leonian. As a check a fourth inoculation was made at another point.

The results are shown in Fig. 1. Each point represents the mean of 5 readings, except in a few cases in which only 4 readings were made. It is seen that there is no significant difference in the diameter of cultures at the places where disks of sour orange and sweet orange bark had been placed, but they were significantly larger than the controls and the thalli of the thiamin disks. As in previous experiments, thiamin did not affect the diameter.

The thickness of the mycelial mat as shown by the galvanometer readings was greatest for the thiamin disks and was substantially greater for the sweet orange disks than for the sour orange ones. No indication of an hourly change in the above effects is detectable.

This experiment, as well as previous ones, gives support to the theory that the differences in susceptibility of citrus species to *Phytophthora* are due, at least in part, to the amount of growth substances in the bark of the host. Factor *L* would account for the differences between varieties of sweet orange, whereas thiamin, or substances producing the same effect as thiamin on *Phytophthora*, would account for the difference between the sweet orange and the sour orange.

Lesions of *Phytophthora* gummosis show a characteristic concentric zoning in the inner bark of citrus, each zone corresponding to a period of 24 hr. This zoning can be explained by a periodicity of growth of the fungus in the bark, and such a periodicity might be the result of changes in the amount of growth substances in the bark during the period of 24 hr. No indication of such a periodicity was found in this experiment.

References

1. ROBBINS, W. J. *Bull. Torrey Botan. Club*, **65**, 257 (1938).
2. BITANCOURT, A. A., and ROSSETTI, V. *Rev. brasil. biol.*, **9**, 525 (1949).
3. ———. *Proc. VII Intern. Botan. Congr., Stockholm, 1950* (in press).
4. ———. *Proc. Congr. Sul-Americano Investigadores Materias Agronomicas, La Estanzuela, Uruguay, 1949* (in press).

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Studies on Arthropod Cuticle. VII, Patent and Masked Carbohydrate in the Epicuticle of Insects[1, 2]

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The histochemical test for polysaccharides and glycoproteins involving the application of Schiff's re-

[1] Paper No. 2693, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul.

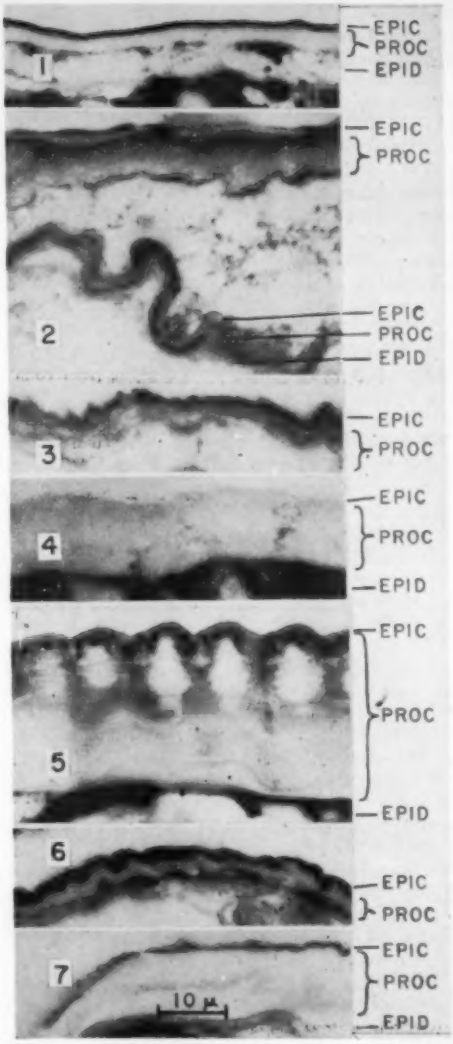
[2] The work described in this paper was done under terms of a contract between the Office of the Surgeon General, U. S. Army, and the University of Minnesota. Under the terms of this contract the Army neither restricts nor is responsible for the opinions or conclusions of the author.

agent after oxidation with periodic acid (*1*) is not always positive even though carbohydrate may demonstrably be present. This can readily be shown by examination of the staining reactions of cuticle sections from insects. The procuticle fraction of these cuticles contains the polysaccharide chitin, usually to the extent of 25–60% of the dry weight (*2*). Pure chitin gives an intense red color with this test (provided the sample has not been air-dried); soft procuticle, especially in early stages of cuticle development, gives a pink to light-red color; lightly sclerotized cuticle that has not yet developed any distinct coloration of its own stains only a very faint pink or, in some species, not detectably; more strongly sclerotized cuticles, ranging in natural coloration from light- to dark-amber, are not detectably altered in color by this technique. However, sclerotized cuticle that is negative to this reaction may be treated with hot 10% NaOH solution to purify the chitin; it then gives an intense reaction. With the fairly well-known chemical chitin (*2*), then, we have a polysaccharide which in its natural condition may be either patent or masked to the periodic acid–Schiff's reaction.

A similar situation is encountered with the insect epicuticle, the extremely thin outer subdivision of the cuticle, except that here the carbohydrate has not been identified. The cuticle of insects and other arthropods consists typically of (1) a relatively thick inner chitin-protein portion called the procuticle (which may become differentiated into a sclerotized exocuticle and an unsclerotized endocuticle), and (2) a very thin outer portion characterized by the absence of chitin or at least by being dispersed by hot alkaline solutions and hence negative to the van Wisselingh color test for chitin detection. Qualitative reactions have been used to indicate that the epicuticle contains protein, lipid (probably as lipoprotein), sterol, waxes, polyphenols, and perhaps enzymes involved in sclerotization (*2, 3*). There are no reports in the literature of a carbohydrate being present in the epicuticle, but an unidentified carbohydrate was extracted from *whole* cuticles by Trim (*4*).

In the course of a study in progress on the cuticle of bees, it was noticed that the epicuticle sometimes did not stain red after the periodic acid–Schiff's reagent treatment. Accordingly, a short survey was made covering various representative insect groups and stages. The technique of Hotchkiss (*1*) was followed, using his acid solution B. (A few tests with acid solution A, which aids in the retention of water-soluble compounds, gave the same results.) Control slides were run concurrently with the omission of oxidation by periodic acid; they were consistently negative. Test sections included the adult integument of the firebrat (*Thermobia domestica*), a cockroach (*Periplaneta americana*), a beetle (*Tribolium confusum*), and the honeybee (*Apis mellifica*); and larval or nymphal integuments of a bug (*Sinea diadema*), the wax moth (*Galleria mellonella*), a mosquito (*Aedes aegypti*), and a blowfly (*Sarcophaga bullata*).

The epicuticle was recognizable as a single red line in the larva of *Aedes* (Fig. 1) and in the spiracular chamber and tracheae of a teneral adult of *Tribolium*. The entire cuticle was stained pink without the epicuticle being distinguishable from the procuticle in larvae of *Galleria* (Fig. 5) and in prospective sclerites



FIGS. 1–7. Photomicrographs of 4-μ sections of specimens fixed in Carnoy's fluid and stained only with the periodic acid–Schiff's reagent. All at same magnification. *EPIC* = epicuticle, *EPID* = epidermis, *PROC* = procuticle. (1) Larva of *Aedes aegypti*, (2) larva of *Sarcophaga bullata* showing loosened second instar cuticle with the developing third instar cuticle beneath it, (3) intersegmental membrane of a teneral adult of *Periplaneta americana*, (4) prospective sclerite of a teneral adult of *P. americana*, (5) larva of *Galleria mellonella*, (6) developing intersegmental membrane of adult antenna from old pupa of *Apis mellifica*, (7) intersegmental membrane of antenna from a teneral adult of *A. mellifica*.

of a teneral adult of *Periplaneta* (Fig. 4). The epicuticle was recognizable as composed of two layers, only the outer of which stained red, in the intersegmental membranes of *Thermobia, Periplaneta* (Fig. 3), and adult *Apis* (Fig. 7), in prospective adult sclerites from old *Apis* pupae, and in both larval and puparial cuticles of *Sarcophaga* (Fig. 2). The outer epicuticle stained red, the inner epicuticle pink, in early developmental stages of the adult cuticle in the pupa of *Apis* (Fig. 6). The epicuticle was unstained, and the procuticle nearly or completely negative also, on the dorsum of *Thermobia,* partly or fully sclerotized sclerites of adult *Periplaneta* and *Apis,* and both sclerites and intersegmental membranes of *Sinea* and *Tribolium.*

Accepting this demonstration of a carbohydrate (polysaccharide?) in the epicuticle of numerous insect species, the question of how to interpret the case of those species that give negative results arises. An answer for the honeybee is available. When the adult cuticle is being formed late in pupal life, the outer epicuticle stains red and the inner epicuticle stains pink over all of the antenna (Fig. 6); later in pupal life the outer epicuticle of the sclerites stains only pink, the inner epicuticle seemingly not at all; and still later, at the time of emergence of the adult from the pupa, the outer epicuticle of the intersegmental membrane stains red (Fig. 7), that over the sensory pore plates stains pink, and that over the general sclerites and setae does not stain at all. Less complete data outlined in the preceding paragraph suggest that the same explanation will hold for *Periplaneta* and *Tribolium.* Also, it seems relevant to point out an observed correlation: when the epicuticle stains intensely, the procuticle stains moderately, whereas when the epicuticle is negative, the chitin-containing procuticle is also negative (*Apis, Sinea,* and *Tribolium*) or nearly so (*Thermobia*). Admitting that negative evidence is not proof, the suggestion is still obvious that the insect epicuticle consistently contains a carbohydrate component but that in some species or regions the carbohydrate becomes masked by sclerotization processes.

To the biologist, demonstration of a carbohydrate in the epicuticle is of minor importance in comparison to the concomitant demonstration that epicuticle may vary in composition not only from species to species but also from area to area on one species. Thus, commonly, two types of epicuticle can be shown on one species, and in the honeybee at least three types can be demonstrated on the antennae.[3] Since the work of Wigglesworth and Beament has shown that the epicuticle is the major portion of the effective barrier between the insect and its environment (at least for the passage of water) (*3*), the demonstration of local gross variations is important and, unfortunately, complicates precise analyses of penetration through the cuticle.

[3] Visible differentiation can also be made with Mallory's connective tissue stain, which at different developmental stages and on various areas gives red, blue, purplish, or no staining to the epicuticle of honeybee antennae.

References

1. Hotchkiss, R. D. *Arch. Biochem.*, **16**, 131 (1948).
2. Richards, A. G. *The Integument of Arthropods.* Minneapolis: Univ. Minnesota Press (1951).
3. Wigglesworth, V. B. *Biol. Revs. Cambridge Phil. Soc.*, **23**, 408 (1948).
4. Trim, A. R. H. *Biochem. J.*, **35**, 1088 (1941).

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The Fluoride Content of Placental Tissue as Related to the Fluoride Content of Drinking Water[1]

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Current programs to fluoridate water supplies as a dental caries control measure have stimulated interest in the extent to which the fluoride might be retained by the various tissues of the body. Considerable evidence is available to show that much of the fluoride is excreted in the urine, but there is little information on the possible accumulation or storage of the fluoride not excreted.

A previous study of normal human blood fluoride concentrations of residents of Rochester and Newburgh, N. Y. (*1*), has disclosed blood fluoride as a function of the fluoride concentration in drinking water. Higher levels of blood fluoride were noted for residents of Newburgh, where the fluoridated water supply contains 1.0–1.2 ppm fluoride, than for residents of Rochester, where the supply contains approximately 0.06 ppm.

In this investigation samples of placentae were obtained from the afterbirth of normal patients residing in Rochester and Newburgh, and the fluoride contents determined by the method of Smith and Gardner (*2*) as described for blood. Table 1 shows the distribution of the fluoride content of the placental samples as found for the two cities.

Of the Rochester samples 58% contained less than 50 μg/100 g of tissue, whereas only 17% of the Newburgh samples were in this range. Only one Rochester sample contained more than 200 μg/100 g, but 6 of the Newburgh samples contained more than this concentration. The Rochester samples had a mean concentration of 0.74 ppm fluoride and the Newburgh samples 2.09 ppm, almost three times as much. In the study of blood fluoride concentrations (*1*) the Rochester samples had a mean value of 0.014 ppm fluoride and the Newburgh samples 0.040 ppm—also almost three times as much. Thus the increased level of

[1] This article is based on work performed under contract with the United States Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, N. Y.

TABLE 1

DISTRIBUTION OF FLUORIDE CONTENT OF THE NORMAL HUMAN PLACENTAL SAMPLES FROM ROCHESTER AND NEWBURGH, N. Y.

μg fluoride/ 100 g	Rochester		Newburgh	
	No. samples	Percentage	No. samples	Percentage
0– 49	7	58	2	17
50– 99	2	17	3	25
100–199	2	17	1	8
200–299	1	8	4	33
300–599	0	0	2	17
Totals	12	100	12	100

fluoride in the water resulted in a higher concentration of fluoride in the placental tissue, which may be related to the blood fluoride concentration. Also, it should be noted that both the Rochester and Newburgh placental samples had higher concentrations of fluoride than the respective blood samples. Two explanations are suggested for this observation. First, if fluoride is an essential trace element the placenta may act as a concentrating organ for fluoride, to ensure that the fetus will have adequate fluoride for the developing tissues. Second, since excessive fluoride is toxic, this organ may be acting as a barrier to prevent more than trace amounts of fluoride from reaching the fetus. How much of this accumulating fluoride passes from the placenta to the fetus is yet to be determined. At any rate, the placental concentrations are not of the order of magnitude to cause deleterious effects in the mother.

References

1. SMITH, F. A., GARDNER, D. E., and HODGE, H. C. *J. Dental Research*, **29**, 596 (1950).
2. SMITH, F. A., and GARDNER, D. E. *Ibid.*, **30**, 182 (1951).

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The Significance of Intravas pH in Relation to Sperm Motility[1]

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Important contributions in the field of reproductive physiology have concerned the relation of mammalian sperm activity to the hydrogen ion concentrations of the dilution media (*1–4*). These investigations were studies *in vitro*, generally on seminal sperm, in which the criteria of activity included motility, glycolysis, and oxidative respiration. Emmens' extensive work on rabbit spermatozoa indicated that the pH optimum for motility is in the pH range 7.2 to 7.9, whereas the results of Lardy and Phillips demonstrated a pH of 6.8 as optimum both for motility and respiration. Insofar as they go these data are of considerable practical importance, and probably the apparent discrepancy in results can be resolved on a basis of the chemical nature of the diluents and the relative dependability of the methods used in rating sperm motility. However, in these investigations two fundamental biological problems have been neglected, problems of more significance than the determination of the absolute pH values for optimum activity: (1) the mechanism by which pH changes affect sperm motility, and (2) the biological significance of pH in controlling the motility of sperm *in vivo*, particularly within the male reproductive ducts. This note concerns the second of these problems.

The spectacular achievement of motility by mammalian spermatozoa immediately following ejaculation represents a sudden change in metabolic pattern. When first obtained from the epididymis or from the vas deferens, sperm are immotile but rapidly become active under the new environmental conditions. The initiation of activity of vas sperm *in vitro* has prompted several suggestions as to the nature of the intravas inhibition of motility. Oxygen deficiency, high acidity caused by acid metabolites, and lack of space have been suggested as being mainly responsible for the immotility of sperm while still within the ducts, each of which conditions is modified at the time of ejaculation.

The data presented here indicate that a low pH is not normally found in the vas; an acid condition brought about by lactic acid or carbon dioxide accumulation does not prevail. On the other hand, we have evidence (to be presented elsewhere) that a very low intravas oxygen tension combined with a deficiency of carbohydrate substrate may indeed be the significant limiting factor for sperm motility and that this, rather than the hydrogen ion concentration, inactivates the vas sperm. This brings into line the motility regulation of mammalian sperm with that of sea-urchin sperm, in which it is now clear that oxygen lack is the important inactivating physical factor (*5*). Although the present suggestion is not new in regard to the relative insignificance of hydrogen ion concentration in inhibiting the motility of mammalian sperm in the vas deferens, no direct measurements of intravas pH have yet been recorded.

Mature, breeding buck rabbits were investigated under Nembutal anesthesia; pH determinations were made with the Beckman (Model G) pH meter, using a standard microglass electrode of approximately 5-μl capacity. The capillary containing the material to be measured was carried in a vessel of hydrochloric acid-quinhydrone solution connected to the instrument through an HCl-platinum wire junction. A calomel electrode completed the circuit. The electrodes were standardized against buffers at pH 7.00 and 4.00 before, and usually after, each determination. All measurements were made at room temperatures. Following the abdominal incision and exposure of the vas deferens, this duct was clamped off and removed. The

[1] Supported by a grant-in-aid from the Planned Parenthood Federation of America.

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capillary electrode was immediately introduced into the vas, sperm withdrawn into the capillary, and the pH measured. Determinations could be made within 2 min following the initial incision. In one series of experiments the circulation to and from the vas was closed off, and measurements were made on the sperm mass at various times up to 1 hr following the vascular constriction.

For comparative purposes the hydrogen ion concentration of semen, collected by means of an artificial vagina, was determined. Finally, the effect of pH on the motility of seminal sperm, resuspended in phosphate buffer, was observed in a series of buffers ranging from pH 5.6 to 7.4.

The motility of sperm—and motility rather than metabolic activity was under investigation here—was rated following the method of Emmens in which four degrees of motility from excellent (#4) to poor (#1) were noted, no motility having a value of zero. We have preferred to omit the half-steps in Emmens' index because of the necessarily subjective nature of the rating, although the method and its reliability are quite sound.

The pH of vas deferens sperm. The hydrogen ion concentration of the sperm mass transferred directly from the vas to the capillary electrode, without contact with air, ranged from pH 6.21 to 7.35 (Table 1).

TABLE 1

INTRAVAS PH OF NEMBUTALIZED RABBITS DETERMINED WITH THE MICROGLASS ELECTRODE

Experimental animal	pH	Time after incision (min)
1	7.10	15
2	6.92	25
3	6.40	5
4	6.35	7
5	6.81	5
6	6.88	5
7	6.91	7
8	6.21	5
9	6.83	5
10	6.61	20
11	6.85	9
12	6.55	14
13	7.10	3
14	7.35	2

A significant factor in the variation here proved to be the time lapse between the beginning of the operation—or more particularly the interruption of the blood supply to the vas—and the moment the pH was determined. In animals measured very soon after the beginning of the operation (Nos. 13 and 14) the intravas pH was high, approximating the pH of blood, 7.45. As the interval increased, the pH generally decreased, except in those animals in which the vas sperm were not very active (No. 1).

The possible accumulation of acid following an impairment of the blood supply was tested by clamping the vessels to the vas deferens and determining the pH after appropriate time intervals (Table 2). After the first determination of pH 6.34 following a 5-min interval, all the values were between pH 5.0 and 6.0 (Fig. 1).

TABLE 2

INTRAVAS PH FOLLOWING OCCLUSION OF BLOOD VESSELS TO THE VAS DEFERENS

Experimental animal	pH	Tie-off interval (min)
1	6.34	5
2	5.91	10
3	5.84	15
4	5.85	30
5	5.19	40
6	5.69	55

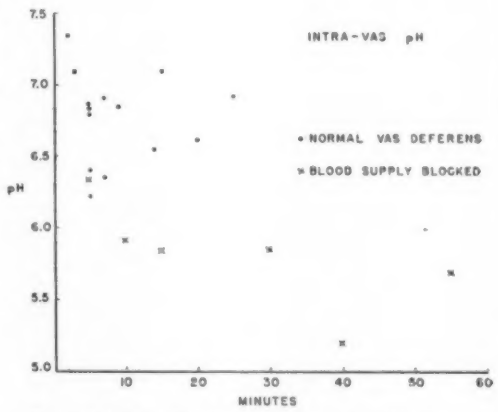

FIG. 1. Intravas pH determinations in the rabbit. Time intervals indicate time from beginning of operation (●), or from moment blood vessels are constricted (◇).

Although it was not possible to observe the sperm in every experiment in which a pH measurement was recorded, in those instances in which observations were made the vas sperm remained immotile until contact with air. Following the pH determination, the sperm in the capillary electrode became motile on exposure to air even though the pH had decreased to values as low as 5.85.

The pH of seminal sperm. It seemed desirable to verify, with this method, the effect of pH on the motility of seminal sperm. The average value for the rabbit sperm ejaculate was 7.3 to 7.4, with a range from 6.75 to 8.10. The variability is not unexpected, owing to the different and relatively independent sources of the seminal components, which vary widely in their own hydrogen ion concentrations (*6*).

In order to test the effect of pH on the motility of seminal sperm, the cells were isolated from the plasma by double centrifugation and resuspension in phosphate buffers over the pH range 5.61 to 7.39. Tribasic sodium phosphate (0.1 *M*) and monobasic potassium phosphate (0.1 *M*) were mixed to give the appropriate

buffer steps. These buffers obviously are not the ideal nutrient solutions, and there may well be some detrimental ionic effect, but they proved adequate to determine the immediate effect of pH per se on the sperm in glucose-free medium (Table 3). A subsequent series

TABLE 3

SPERM MOTILITY IN PHOSPHATE BUFFERS OF VARIOUS PH, WITHOUT GLUCOSE

(Motility ratings indicated from very motile [++++] to immotile [−])

Time (hr)	pH 7.39	6.81	5.91	5.61	Tyrode solution (pH 7.35)
0.0	++++	++++	++++	++++	++++
1.0	++++	++++	++++	++	++++
1.7	++++	++++	++++	+	+++
2.5	+++	++++	+++	+	+++
3.5	++	+++	++	−	++
4.5	++	+++	+	−	++
6.0	+	+++	−	−	++

of determinations was made in which glucose as substrate was added to the buffer mixtures (Table 4). The results not only show clearly that a pH of 6.0 will support motility for several hours, but indicate that the optimal pH is in the region of 6.8, somewhat less than the average pH of the ejaculate but precisely at the point previously demonstrated by Lardy and Phillips as the optimum pH for both motility and respiration of rabbit sperm.

TABLE 4

SPERM MOTILITY IN PHOSPHATE BUFFERS OF VARIOUS PH, WITH ADDED GLUCOSE

(*M*/100 final conc; motility ratings as in Table 3)

Time (hr)	pH 7.39	6.81	5.91	5.61	Tyrode solution (pH 7.35)
0.0	++++	++++	++++	++++	++++
0.3	++++	++++	++++	++	++++
0.6	+++	++++	++++	+	++++
1.6	++	+++	+++	−	++++
3.3	+	++	++	−	+++
5.0	−	+	+	−	++
22.5	−	+	+	−	++

These results minimize high hydrogen ion concentration as of any great consequence in inhibiting the motility of spermatozoa within the male tract. The sperm are immotile in spite of a pH which approximates that of neutrality. No lactic acid or carbon dioxide normally accumulates in any significant quantities because these metabolic end products are carried off by an adequate blood supply. However, even when these substances are allowed to increase, the potential motility of the spermatozoa is not lost; as air is admitted, high sperm motility is acquired. Likewise, decreasing the pH around seminal sperm does not immediately impair their motility unless a value of pH 6.0 or less is reached. Emmens demonstrated that rabbit sperm may be exposed to a pH of 5.8 before motility is lost; exposure to pH 4.5, although temporarily immobilizing the sperm, may be tolerated if the sperm are returned within an hour to pH 8.0.

The question of the source of the acid metabolites accumulated in the vas deferens, the circulation of which is restricted, is provocative in the light of the claim that there is little more than a trace of glycolyzable carbohydrate present within the tract (*7, 8*). However, as the intracellular glycolyzable and oxidative reserves of the spermatozoa cannot be utilized over too long a period of time, it is likely that some substrate, probably glucose, is made available by the blood supply previous to ejaculation to nourish the sperm while in the tract.

References

1. EMMENS, C. W. *J. Physiol.*, **106**, 471 (1947).
2. LARDY, H. A., and PHILLIPS, P. H. *Am. J. Physiol.*, **138**, 741 (1943).
3. WINCHESTER, C. F., and MCKENZIE, F. F. *Proc. Soc. Exptl. Biol. Med.*, **48**, 654 (1941).
4. WINDSTOSSER, K. *Klin. Wo-chschr.*, **14**, 193 (1935).
5. ROTHSCHILD, LORD. *J. Exptl. Biol.*, **25**, 344 (1948).
6. HUGGINS, C., SCOTT, W. W., and HEINEN, J. H. *Am. J. Physiol.*, **136**, 467 (1942).
7. HUGGINS, C. B., and JOHNSON, A. A. *Ibid.*, **103**, 574 (1933).
8. MANN, T. *Advances in Enzymol.*, **9**, 329 (1949).

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Inhibition of Sperm Motility by Tetrazolium Salts[1]

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The use of tetrazolium salts in cytochemistry, and specifically as indications of dehydrogenase activity, has been extensively described in a number of papers (*1–19*). When added to appropriate biological systems, these salts generally function as hydrogen acceptors and are irreversibly reduced to their colored derivatives: 2,3,5-triphenyltetrazolium chloride becomes red formazan, neotetrazolium chloride gives rise to a purple diformazan, and ditetrazolium chloride forms an intense blue diformazan. Besides dehydrogenation, tetrazolium reduction has also been associated with cysteine desulfurase activity (*20*) and reactions involving phosphate ions (*21*). Much of the tetrazolium literature has been surveyed recently by Smith (*22*).

A physiological characteristic of tetrazolium which bears reporting is its ability to inhibit motility of mammalian spermatozoa. In the presence of glycolyzable sugar (*M*/100), sperm which have been thoroughly washed and resuspended in Tyrode's solution are unaffected by the addition of 2,3,5-triphenyltetrazolium chloride in concentrations up to *M*/50, but in the absence of sugar a concentration of tetrazolium of *M*/10,000 rapidly inhibits motility of the sperm

[1] Supported by a grant-in-aid from the Planned Parenthood Federation of America.

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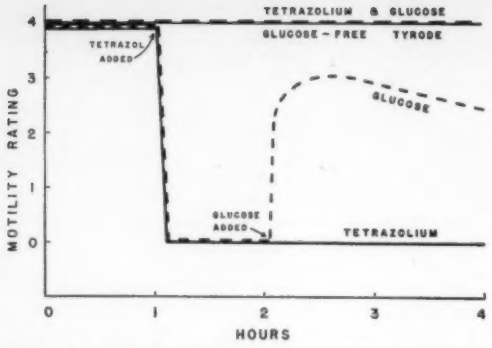

FIG. 1. Inhibition of rabbit sperm motility by 2,3,5-triphenyltetrazolium chloride in absence of glucose (lower curve). Addition of glucose to tetrazolium-treated sperm permits motility.

(Fig. 1). If motility is thus impaired, it may be reacquired by the addition of glucose within an hour following tetrazolium treatment. To this extent the reaction is reversible.

The direct counteraction by glucose of the tetrazolium suggested that the salt might be undergoing a reduction by the sugar, thereby rendering it unable to take part in the hydrogen transfer mechanisms of the cells. Tests with various sugars, however, and with photoreduced (red) tetrazolium indicate that this is not the case. Glucose and mannose are equally effective in preventing the inhibitory action of the tetrazolium; galactose and maltose are less effective; fructose, sucrose, and lactose are least effective; and ribose has no effect whatever. The molar ratios of glucose and triphenyltetrazolium chloride may be varied over a tenfold range without changing the reaction. A small quantity of tetrazolium inhibits motility; likewise a small amount of glucose, even in the presence of a large excess of tetrazolium, can maintain motility. No protective action against the tetrazolium was displayed by solutions ($M/100$–$M/1000$) of succinate, malate, fumarate, or malonate. The study has thus far been conducted primarily with 2,3,5-triphenyltetrazolium chloride and its effects on rabbit sperm, but both neo- and ditetrazolium chlorides produce the same types of response, and in fact give equivalent inhibition at lower concentrations. The reactions on rabbit sperm have been paralleled on human and bovine sperm.

Rabbit spermatozoa can generally maintain motility for periods up to 2 days at room temperature if provided with either glycolyzable energy sources (e.g., glucose, fructose, or mannose), or with an adequate oxygen supply. Under anaerobic conditions (tank nitrogen) sugar is essential (if sugar is absent oxygen is required) to support motility for more than a few minutes. These systems are sensitive to the glycolytic inhibitors, iodoacetate and fluoride, and to the oxidative poisons, cyanide and azide. If tetrazolium is used in combination with these compounds, motility is impaired in suspensions in which glucose is present but in which its utilization is prevented by iodoacetate or fluoride. On the other hand, so long as glucose is available, cyanide and azide sensitivity remains the same in the presence and absence of tetrazolium.

Attempts to elucidate the mechanism of action of tetrazolium salts on mammalian sperm have established these facts: (1) motility is impaired immediately following the addition of the salt to the sperm suspension; (2) the reaction need not proceed to the red formazan stage; (3) the inhibition of motility can occur if colored photoreduced tetrazolium is used; (4) the reaction can be reversed by the addition of suitable carbohydrate; (5) the reducing value of the sugar does not seem to be critical, although its enzymatic utilization by the cells may be; and (6) the inhibition is not counteracted by succinate, malate, fumarate, or malonate. It is justifiable to conclude at present, therefore, that the tetrazolium effect on sperm motility is not merely a reduction accompanying dehydrogenase activity, but is a physiological inhibition of a different order. The physical and physiological aspects of this impairment are being further investigated.

References

1. ANTOPOL, W., GLAUBACH, S., and GOLDMAN, L. *Trans. N. Y. Acad. Sci.*, Ser. II, **12**, 156 (1950).
2. ATKINSON, E., MELVIN, S., and FOX, S. W. *Science*, **111**, 385 (1950).
3. COTTRELL, H. J. *Nature*, **159**, 748 (1947).
4. FLEMION, F., and POOLE, H. *Contribs. Boyce Thompson Inst.*, **15**, 243 (1948).
5. FRED, R. B., and KNIGHT, S. G. *Science*, **109**, 169 (1949).
6. JENSEN, C. O., SACKS, W., and BALDAUSKI, F. A. *Ibid.*, **113**, 65 (1951).
7. KUHN, R., and JERCHEL, D. *Ber.*, **74**, 949 (1941).
8. KUN, E., and ABOOD, L. G. *Science*, **109**, 144 (1949).
9. LAKON, G. *Ber. deut. botan. Ges.*, **60**, 299, 434 (1942).
10. MATTSON, A. M., JENSEN, C. O., and DUTCHER, R. A. *Science*, **106**, 294 (1947).
11. NORTHCRAFT, R. D. *Ibid.*, **113**, 407 (1951).
12. PORTER, R. H., DURRELL, M., and ROMM, H. J. *Plant Physiol.*, **22**, 149 (1947).
13. PRATT, R., and DUFRENOY, J. *Stain Technol.*, **23**, 137 (1948).
14. ROBERTS, L. W. *Bull. Torrey Botan. Club*, **77**, 372 (1950).
15. ———. *Science*, **113**, 692 (1951).
16. SELIGMAN, A. M., and RUTENBURG, A. M. *Ibid.*, 317.
17. STRAUS, F. H., CHERONIS, N. D., and STRAUS, E. *Ibid.*, **108**, 113 (1948).
18. WAUGH, T. D. *Ibid.*, **107**, 275 (1948).
19. ZWEIFACH, B. W., BLACK, M. M., and SHORR, E. *Proc. Soc. Exptl. Biol. Med.*, **74**, 848 (1950).
20. RUTENBURG, A. M., GOFSTEIN, R., and SELIGMAN, A. M. *Cancer Research*, **10**, 113 (1950).
21. DUFRENOY, J., and PRATT, R. *Am. J. Botany*, **35**, 333 (1948).
22. SMITH, F. E. *Science*, **113**, 751 (1951).

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On a Thiazolone Compound from Thiamine Disulfide

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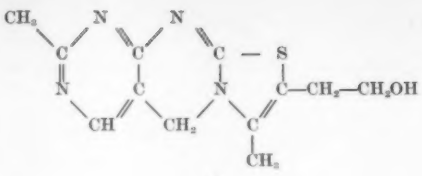
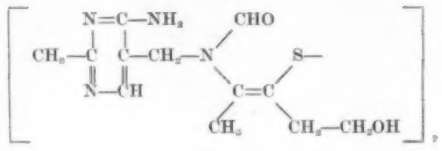
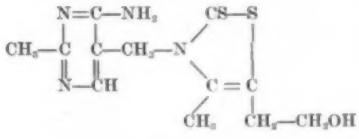
In 1940 Zima *et al.* (*1*) obtained thiochrome (I) and a product melting at 233°–4° by heating thiamine disulfide (II) in ethylene glycol. From the analytical



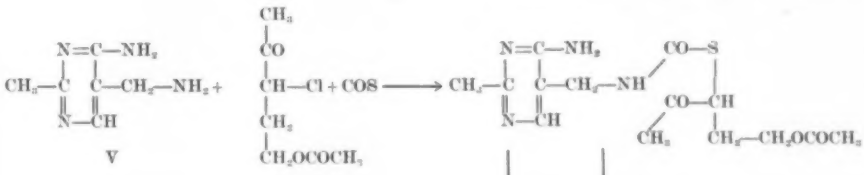
I



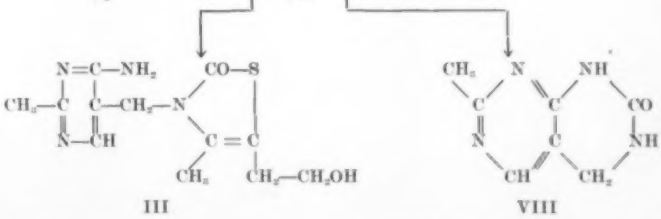
II



IV



V VI VII



III VIII

data they assumed the new product to be *N*-(2′-methyl-4′-amino-pyrimidyl-(5′))-methyl-4-methyl-5-β-hydroxyethyl-thiazolone (III). However, it has so far been believed that III might be formed as the first product when thiamine is oxidized with alkaline potassium ferricyanide, but spontaneous elimination of water to give I might make its isolation difficult. Therefore, the present investigation was undertaken to ascertain whether such a compound (III) really exists and, if so, to identify it by synthesis. Having previously synthesized the corresponding thiathiazolone compound (IV) (*2*), we employed the same method for the preparation of Type III.

Carbon oxysulfide was passed into a solution of 2-methyl-4-amino-5-aminomethyl-pyrimidine (V) and γ-aceto-γ-chloro-propyl acetate (VI) in alcohol containing a little ammonia. An exothermic reaction occurred, to yield S-(α-aceto-γ-acetoxy-propyl) *N*-(2-methyl-4-amino-pyrimidyl-(5))-methyl-thiocarbamate (VII), colorless needles from alcohol, mp, *ca* 250° (dec), (softening at *ca* 170°).[1]

Anal calcd for $C_{14}H_{20}O_4N_4S$: C, 49.40; H, 5.92; N, 16.46. Found: C, 49.42; H, 6.25; N, 16.02.

Compound VII was also obtained by the interaction of VI and ammonium *N*-(2-methyl-4-amino-pyrimidyl-(5))-methyl-thiocarbamate, the latter being prepared from carbon oxysulfide, V, and ammonia. When VII was heated at 170° C or treated with an aqueous solution of caustic alkali, it was converted into 2-oxo-7-methyl-1,2,3,4-tetrahydro-pyrimido-(4,5-d)-pyrimidine (VIII) (*3*). The same kind of reaction was also observed with α-aceto-γ-acetoxy-propyl *N*-(2-methyl-4-amino-pyrimidyl-(5))-methyl-dithiocarbamate (*2*), an intermediate of IV.

On the other hand, treatment of VII with HCl caused thiazolone ring closure and hydrolysis of the acetyl group to give the desired thiazolone (III) as follows: A solution of VII in *ca* 5% HCl was heated on a water bath for 10 min, and the resulting solution was made alkaline, whereupon III separated as fine crystals, which crystallized from dilute alcohol in colorless needles melting at 233°–234°.

Anal calcd for $C_{12}H_{16}O_2N_4S$: C, 51.41; H, 5.75; N, 19.99. Found: C, 51.31; H, 5.87; N, 20.29.

The thiazolone (III) thus obtained and the one prepared from II in the manner of Zima *et al.* showed no depression of melting point when fused with each other, and proved to be identical in crystal form, solubilities, etc. Both were acetylated with acetic anhydride and pyridine to give the same acetyl derivative melting at 174°.

Anal calcd for $C_{14}H_{18}O_3N_4S$: C, 52.17; H, 5.63; N, 17.38. Found: C, 52.31; H, 5.65; N, 17.30.

It was found difficult to convert III into I by heat-

[1] The melting point depends on rate of heating.

ing III in a high-boiling solvent, heating as such above its melting point, or by other treatments, so that the hitherto believed mechanism of thiochrome formation from thiamine was proved not to be correct.

Recently Sykes and Todd (*4*) attempted the synthesis of the same compound (III). Although they got the same intermediate (VII) from VI and potassium *N*-(2-methyl-4-amino-pyrimidyl-(5))-methyl-thiocarbamate, they failed to convert it into III.

References

1. Zima, O., and Williams, R. R. *Ber.*, **73**, 941 (1940).
2. Matsukawa, T., and Iwatsu, T. *J. Pharm. Soc. Japan*, **70**, 28 (1950); *ibid.*, **71**, 455 (1951).
3. Tomita, M., *et al. Ibid.*, **68**, 154 (1948).
4. Sykes, P. V., and Todd, A. R. *J. Chem. Soc.*, 534 (1951).

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A New Occurrence and Description of the Fossil *Arthrophycus*

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A new occurrence of the hitherto doubtful or unclassified fossil *Arthrophycus* is reported here. It was found last summer making up most of the west wall of an abandoned quarry in the Tuscarora on the north side of McKee Gap near Roaring Spring, Blair Co., Pa. The fossil occurs in tremendous profusion in a slabby, mottled, red-to-grey sandstone having a nearly vertical dip, near the Clinton contact. Fig. 1 shows a slab (with an 18-in. scale) removed from the wall. Fig. 2 is a closer view of another slab. The fossiliferous sandstone slabs, which are up to 2 ft thick, are separated by fissile, dark-grey shale, which is barren of *Arthrophycus*. The same fossil was found only sparingly in the lower Tuscarora near the Juniata contact at the crest of Tussey Mountain almost directly east of McKee Gap. Both localities are similar to other occurrences described for the Medina group.

The earliest description of this species is found in Amos Eaton's report of 1820 (*1*) where it is accurately described but not named, and is assumed to belong to the Vermes. In 1831 Richard Harlan (*2*) described the same fossil under the name of *Fucoides alleghaniensis*, or *F. brongniartii*, implying its algal origin. R. C. Taylor (*3*) in 1834 reprinted Harlan's report emphasizing the fossil's plant character, and again in 1835 reported in detail on the beds in which fucoids occur (*4*). T. A. Conrad (*5*) in 1839 described the specimen as *F. harlani*. The generic name *Arthrophycus alleghaniensis* was given by Hall in 1852, and H. R. Goeppert (*6*) somewhat later in 1852 named it *Harlania halli*. Finally, in 1893, Joseph F. James (*7*) decided that, according to accepted nomenclatorial procedure, the specimen's name *Arthrophycus alleghaniensis* (*Harlan*) *Hall*, as given by Hall, should be retained.

Admittedly, owing to the complete lack of internal structure, the classification of the specimen is problematical, yet its status as a plant seems to have been strongly indicated over one hundred years ago and time and again during the past century. Nevertheless

Fig. 1.

FIG. 2.

Arthrophycus in modern literature and textbooks is usually referred to as a fossil worm or as a worm burrow. Such references fail to consider the evidence for paleobotany, although the generic name *Arthrophycus*, meaning "jointed seaweed," has not been disputed.

The fossil usually consists of a stem ½"–¾" in diameter, dividing dichotomously, or frequently being multibranched (Figs. 1, 2). Its surface shows closely spaced rings that form distinct transverse ridges. Individuals are of variable length, some having been traced for 3 ft without interruption. The annular ridged pattern is incompatible with the idea of a worm burrow, and the great extent of its branches is incompatible with the idea of direct remains. It is quite possible that the annular ridges are relics of structures that served to strengthen the primitive plant in the shifting shore currents. The early Silurian was at best the dawn of our flora, and the structure of the fossil suggests a primitive hollow, cylindrical tube, possibly filled with cytoplasm.

Longitudinal and transverse sections, also surface polishing, have not revealed any surface structure or even epidermal structure of a single layer. In fact, the fossils are completely integrated with the matrix except for their surface form, so that they are probably casts. Their surface texture is usually finer grained than the rock matrix. These cylindrical "algae" may have been completely filled and replaced by sand and mud.

In correlating *Arthrophycus* with modern fucoids several similarities should be considered. *Arthrophycus* occurred in great masses, apparently in shallow water. Its attitude and structure would indicate that layers of plants were covered by subsequent layers, which would account for their entangled masses. Present fucoids similarly occur in matted profusion in the littoral zone, and shallow-water flora is often covered with sand or silt. Most of the evidence suggests floral origin of this fossil, and the botanical rather than the faunal character of *Arthrophycus* should be emphasized.

References

1. EATON, A. *Index to the Geology of the Northern States.* Troy, N. Y.: W. S. Parker, 211 (1820).
2. HARLAN, R. *J. Acad. Nat. Sci. Phila.*, **6**, 289 (1831).
3. TAYLOR, R. C. *Loudon's Mag. Nat. Hist.*, **7**, 27 (1834).
4. ———. *Trans. Geol. Soc. Penn.*, **1**, 5 (1835).
5. CONRAD, T. A. *Second and Third Annual Reports of the Paleontological Department of the Geological Survey, N. Y.*, 60 (1839).
6. HALL, J. *Paleontology of New York*, Vol. 2. *Organic Remains of Lower Middle Division of New York System.* Albany: Geol. Survey of New York, 5 (1852).
7. JAMES, J. F. *J. Cincinnati Soc. Nat. Hist.*, **16**, (2, 3), 82 (1893).

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Antibiotic Feed and Vitamin B_{12} Supplements for Lactating Dairy Cows

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Evidence is accumulating that aureomycin is of value to young calves, resulting in increased growth and reduced incidence of scours (*1–5*), although earlier work by Bell *et al.* (*6*) using steers, and by Colby *et al.* (*7*) with lambs, indicated adverse effects on feeding aureomycin to ruminants. The animals lost weight and showed anorexia and diarrhea.

No report has been found in the literature on the effect of supplementing the ration of lactating dairy cows with antibiotics or vitamin B_{12}. The present work concerns the feeding of a 1% level of an aureomycin,[1] tyrothricin,[2] or vitamin B_{12} supplement[3] to lactating cows over a period of 60 days without any detrimental effect to the animals or the milk, or any increase in the vitamin B_{12} content of the milk.

Four groups of 5 Holstein cows each were used. They received the regular LSU herd ration. Group I served as a control, Group II received 130 mg aureomycin daily, Group III received 130 mg tyrothricin daily, and Group IV received 0.83 mg vitamin B_{12} daily. All animals had good appetites and showed no evidence of diarrhea whether they were consuming the antibiotics or vitamin B_{12}.

Standard bacterial plate counts were made biweekly on the milk of each group, immediately after milking and after a 12-hr incubation period at 35° C. The results showed that the feeding of antibiotics had no affect on the bacterial flora of the milk. All milk samples developed lactic acid on incubation and produced a normal acid curd. This indicates that the antibiotics were probably not coming into the milk, or if present at all were of such a low concentration as not to interfere with curd formation. This is of interest, since several investigators (*8, 9*) have re-

[1] Courtesy Lederle Laboratories Division, American Cyanamid Co., Pearl River, N. Y.
[2] Courtesy S. B. Penick & Co., New York.
[3] Courtesy Merck & Co., Inc., Rahway, N. J.

ported that antibiotic treatment of mastitis by intramammary infusion resulted in milk containing sufficient antibiotic to result in the production of inferior cheese as well as other dairy products.

The addition of a 4% level of a vitamin B_{12} supplement (3.3 mg vitamin B_{12} daily) to the ration of lactating cows also did not result in any increase in the vitamin B_{12} level of the milk when assayed microbiologically (*10*).

Further details of this work will be published elsewhere.

References

1. Rusoff, L. L. *J. Animal Sci.*, **9**, 666 (1950).
2. Bartley, E. E., Fountaine, F. C., and Atkeson, F. W. *Ibid.*, 646.
3. Loosli, J. K., and Wallace, H. D. *Proc. Soc. Exptl. Biol. Med.*, **75**, 531 (1950).
4. Rusoff, L. L., and Davis, A. V. *J. Dairy Sci.*, **34**, 500 (1951).
5. Rusoff, L. L., Davis, A. V., and Alford, J. A. *J. Nutrition*, **45**, 289 (1951).
6. Bell, M. C., Whitehair, C. K., and Gallup, W. D. *J. Animal Sci.*, **9**, 647 (1950).
7. Colby, R. W., Rau, F. A., and Miller, J. C. *Ibid.*, 652.
8. Bell, W. B., *et al. J. Dairy Sci.*, **34**, 675 (1951).
9. Krienke, W. A. *Am. Milk Rev.*, **12**, 54 (1950).
10. Skeggs, H. R., *et al. J. Biol. Chem.*, **184**, 211 (1950).

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Desmethylcolchicine, a Constituent of USP Colchicine[1]

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In purifying a batch of USP colchicine for biological studies we have found that the material contains an appreciable amount (*ca* 4%) of a second alkaloid, as well as minor amounts of other constituents. In view of this we believe that biological investigators using USP colchicine would be well advised to repurify the material.

Colchicine is generally purified by adsorbing the impure alkaloid on alumina and eluting the pure colchicine with chloroform (*1*). The column of alumina thus eluted often retains an intense yellow color. If methanol chloroform (1:99) is then used as the eluting agent a compound may be recovered (up to 4% based on the weight of impure colchicine) having the properties of desmethylcolchicine (one of the methoxyl groups in ring A demethylated). The evidence for this consists in the facts that the compound $C_{21}H_{23}O_6N$, (*a*) contains three methoxyl groups, (*b*) yields colchicine on treatment with diazomethane, and (*c*) gives a color with ferric chloride only after it has been heated in dilute HCl (presence of an enol ether).

[1] This investigation was supported (in part) by a research grant from the National Cancer Institute of the National Institutes of Health, USPHS.

TABLE 1

	Desmethylcolchicine	Substance C (*2*)
Melting point	176°–190°; 275.5°–277°	176°–182°
$[\alpha]_D^{25}$ ($CHCl_3$)	−143.6°* (C = 2) −152.0°* (C = 1)	−130.7°† (C = 2.0118)
λ (log ε)		
In alcohol	243.5 μ (4.47) 353 μ (4.21)	245 μ (4.54) 352.5 μ (4.27)
In 0.05 *N* alkali	249 μ 376.5 μ	250 μ 379 μ
Acetyl derivative mp	225°–226.5°	231°–233° (*2*) 225° (*3*)
$[\alpha]_D^{20}$ ($CHCl_3$)	−90.7° (C = 0.7)	−115° (C = 0.671)

* Dried at 155°.
† Dried at 50°.

Desmethylcolchicine is obtained as yellow prisms from ethyl acetate-ether containing a trace of chloroform. It turns to a glass at *ca* 176°–190°, recrystallizes at *ca* 200°–210°, and melts finally at 275.5°–277°. No chemical changes are involved in these transitions. The compound retains solvents and had to be dried to constant weight at 155° *in vacuo* before the following analytical data were obtained:

Anal calcd for $C_{21}H_{23}O_6N$: C, 65.44; H, 6.01; $3CH_3O$, 24.15.
Found: C, 65.42; H, 5.81; CH_3O, 24.14.

Santavý and Reichstein (*2*) recently reported the isolation of a number of new constituents from the seeds of *Colchicum autumnale*, including a desmethylcolchicine designated by them as "Substance C." Substance C gave the same reactions as the desmethylcolchicine described here. A comparison of the physical properties of the compounds and of certain derivatives is shown in Table 1.

Although the data for desmethylcolchicine and Substance C agree only fairly well in some particulars, the agreement of the absorption spectra in neutral and alkaline solution is good. We believe there is sufficient over-all correspondence to assume the compounds identical. It should be noted that a double melting point may have been overlooked in the case of Substance C.

The biological effects of desmethylcolchicine are now being studied.

References

1. Ashley, J. N., and Harris, J. O. *J. Chem. Soc.*, 677 (1944).
2. Santavý, F., and Reichstein, T. *Helv. Chim. Acta*, **33**, 1606 (1950).
3. Santavý, F. *Pharm. Acta Helv.*, **25**, 248 (1950).

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Comments and Communications

Prehistoric Sutton Hoo

SINCE the discovery of the archaeological treasure of Sutton Hoo (*1*) in Suffolk, England, little attention has been paid to any of the earlier horizons that occupy the immediate area. Basil Brown, of the Ipswich Mansion Museum (*2*), states that, during the 1938 excavations at the site in question, Neolithic and some Bronze Age flints were found, along "with sherds of Beaker pottery which were discovered in the mound content when the trenches were dug through three barrows." In the (80-foot wooden) ship mound itself, "when the trench was widened (1939), and below the old ground level, six Bronze Age pits or 'hut sites' showed up with hearths and Beaker sherds." However, to date, nothing has been published on these or other earlier remains—largely because the ship burial overshadowed everything else.

Only recently Bruce Mitford, Keeper of British Antiquities, of the British Museum, found a few stone specimens during one of his visits to the site. The author visited this archaeological locality in June 1950, in the company of Peter A. Green, of Ipswich, and collected a few Neolithic stone implements (Fig. 1) on the same spur of land as that occupied by the ship barrow. The presence of a very heavy patina may be noted on a majority of these flint artifacts.

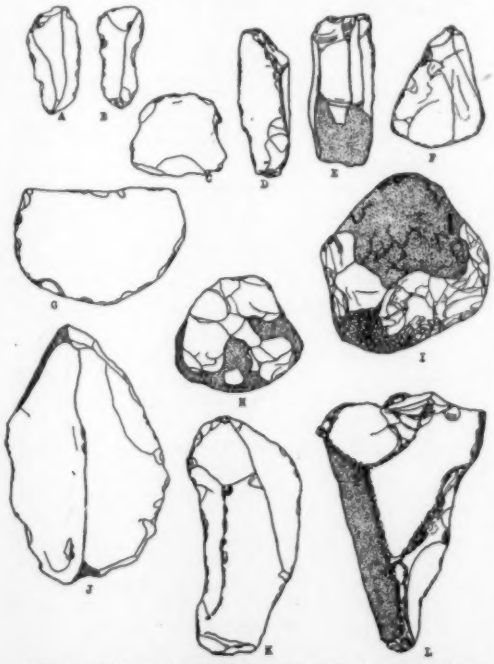

FIG. 1. Artifacts from Sutton Hoo, Eng. *A*, *B*, and *E* represent single and double longitudinal keeled end scrapers; *C*, *F*, and *G*, side scrapers; *D* (and possibly *K*), knife blades; *H*, flint core; *I* and *J*, choppers; and *L*, fist ax.

The sand impression of the ship's hull became a casualty of the recent war when a British soldier drove his tank down the center of the excavations during maneuvers!

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References

1. KENDRICK, T. D., *et al. Antiquity*, **14**, 1 (1940).
2. BROWN, B. Personal communication.

Oldest Natural History Museums and Institutional Herbaria in America[1]

THERE seems to be little question that the first organized society to acquire and exhibit natural history specimens in America was the American Philosophical Society of Philadelphia, which must have begun prior to April 20, 1770 (*1*). In his article on this subject G. G. Simpson states that, about three years later, January 12, 1773, the Library Society of Charles-Towne, S. C., "voted to establish a museum." Next in chronological sequence came the Philadelphia Museum, founded by Charles Wilson Peale in 1785. Dr. Simpson admits the difficulty in deciding how to arrange chronologically the other early museums at Harvard, Yale, Princeton, the Peabody Academy at Salem, Mass., the Academy of Natural Sciences in Philadelphia, etc. A recent issue of *American Heritage* includes an illustration of Rembrandt Peale's Baltimore Museum begun in 1813 "against the advice of his father. It is now one of the nation's outstanding municipal museums," according to D. S. Smith (*2*).

It is the purpose of this brief account to furnish the records of two more natural history museums in the Philadelphia area, as well as a bibliographic note on the Boston Society of Natural History, founded in 1830 (*3*) and included in the ensuing list of early institutional herbaria. All the museums listed were founded early in the nineteenth century. Of those omitted by Dr. Simpson, the first was organized at West Chester, Pa., March 18, 1826. Unlike the Literary and Philosophical Society of South Carolina, which was organized in 1814, the Chester County Cabinet of Natural Science was able to acquire a three-story brick building, which was operated as a sort of lyceum and museum. The building still stands on South Church Street in the borough of West Chester, but was sold to pay off a mortgage. For nearly a century it has been used for various educational and small business enterprises.

The entire mineral cabinet of the Chester County

[1] Acknowledgment is gratefully made to Bart Anderson, librarian of the Chester County Historical Society, and to Helen A. Russell, librarian of the Frances Harvey Green Library, Pennsylvania State Teachers College, both at West Chester, for assistance and loan of historic papers.

TABLE 1

OLDEST INSTITUTIONAL HERBARIA IN THE UNITED STATES

1812—The Academy of Natural Sciences, Philadelphia, Pa.
1826—The Darlington Herbarium, S.T.C., West Chester, Pa.
1829—Amherst College, Amherst, Mass.
1830—Boston Society of Natural History, Boston, Mass.
1836—The New York State Museum, Albany, N. Y.
1838—The University of Michigan, Ann Arbor, Mich.
1850—The Charleston Museum, Charleston, S. C.
1852—The Milwaukee Public Museum, Milwaukee, Wis.
1853—The California Academy of Sciences, San Francisco, Calif.
1856—The University of Missouri, Columbia, Mo.
1857—The Missouri Botanical Garden, St. Louis, Mo.

organization, including books, maps, pictures, and the herbarium of William Darlington, as well as the inevitable collection of stuffed birds, an alligator, birds' eggs, shells, "philosophical apparatus," and miscellaneous curios, was purchased by the West Chester Academy a hundred years ago (1850). In 1869, the State Normal School acquired all the property of the West Chester Academy (*4*). At present, most of the natural history specimens form the nucleus of the Science Museum at the State Teachers College. Since 1827, any local resident or interested visitor may have had access to the collections, although there were at least two periods when moving or renovations were in progress that made it difficult for people to make use of this opportunity.

Another early museum was that of the Delaware County Institute of Science, incorporated February 8, 1836. A two-story building was erected near Rose Tree, Pa., in 1837. At an organization meeting in Upper Providence on September 21, 1833, the parent institution was named the "Cabinet of Natural Science of Delaware County." Its incorporation as an Institute of Science no doubt became necessary when plans were made to erect the building. "Lectures were given in the hall and a museum was established, which received many specimens in every department of natural science" (*5*). It continues to meet in its present building, which was erected in Media, the county seat, in 1867. Its collection of local minerals and its scientific library are quite worthy of note.

In their recent listing of the institutional herbaria of the United States (*3*), Jones and Meadows have done a distinct service to their fellow-taxonomists. In the chronological list of herbaria the first section, including those founded before 1860, should contain two more institutional herbaria.

The Darlington Herbarium at West Chester, Pa., was established by William Darlington, M.D., who began in 1817 to collect a herbarium of the plants of Chester County (*6*). As noted above, he was a prominent figure also in the founding of the Chester County Cabinet of Natural Science (*7*), the first annual report of which was published in 1828 (*8*). Since the oldest specimens now found in the Darlington Herbarium bear the date 1826, there is sufficient evidence to show that it antedates that of the Boston Society of Natural History, which was founded in 1830 (*3*). Jones and Meadows may have omitted this herbarium because the Chester County Cabinet was later dissolved and its collections eventually became the property of the Pennsylvania State Teachers College at West Chester (*4, 9*).

"The question as to when an herbarium ceases to be a private one and when it becomes 'public' or 'institutional' is not always easily decided. For example, Asa Gray gave his herbarium to Harvard University in 1864, when it became an institutional herbarium. But the herbarium of Asa Gray is much older. It may be that the herbarium of the New York State Museum and the Darlington Herbarium are older 'institutionally' than we have listed them. We relied solely upon information submitted in the questionnaires" (*10*). The Herbarium of the New York State Museum at Albany should also appear in the earliest chronological group, as it was founded in 1836.

A revised chronological list of the oldest institutional herbaria in the United States is given in Table 1.

ROBERT BENSON GORDON

Department of Science
Pennsylvania State Teachers College

References

1. SIMPSON, G. G. *Science*, **96**, 261 (1942).
2. SMITH, D. S. *American Heritage*, N. S. **3**, 54 (1951).
3. JONES, G. N., and MEADOWS, E. *Am. Midland Naturalist*, **40**, 724 (1948).
4. SHARPLESS, W. T. *Bartonia*, **14**, 1 (1932).
5. ASHMEAD, H. G. *History of Delaware County, Pennsylvania*. Philadelphia: L. H. Everts, 601, 674 (1884).
6. JAMES, T. P. An Obituary Notice of Dr. William Darlington. Read before the Am. Phil. Soc. (Feb. 19, 1864).
7. DARLINGTON, W. Address to the Chester County Cabinet of Natural Science, West Chester, Pa. (1826).
8. VAN AMRINGE, H. H. Report on the Progress and Present Condition of the Chester County Cabinet of Natural Science (March 15, 1828).
9. GORDON, R. B. *Bartonia*, **22**, 6 (1943).
10. JONES, G. N. Personal communication (May 14, 1951).

A Modified Glass Filter Apparatus for Small Volumes

THE development of a practical UF (ultrafine) filter assembly was accomplished by Morton (*J. Bact.*, **47**, (4), 379 [1944]). It combined the standard UF porosity sintered glass filter of Pyrex[1] with a mantle and joined them with a standard taper glass joint T-S 29/26 to a 250-ml Erlenmeyer-type flask. This was the first all-glass filter apparatus for bacteriological work. It has the advantages that it can be chemically cleaned and that it affords excellent protection from outside contamination by virtue of the glass mantle and standard taper joint closure. The glass joint closure also allows repeated use and sterilization without contamination from the rubber stopper. Frequent changes of the stopper necessitated by heat distortion and fusion to the glass are eliminated. The glass filters have offered a definite advantage over the Seitz or Berkefeld types of filters, which take up and hold

[1] Pyrex brand chemical glass #774, Corning Glass Works, Corning, N. Y.

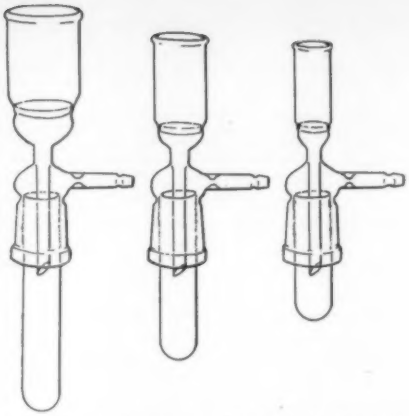

FIG. 1. Sketches of filter assemblies utilizing three sizes of UF filters and three sizes of receiving tubes.

comparatively large volumes by wetting or adsorption —volumes which are held and not passed through to the receiver flask.

The all-glass filter assembly has been widely accepted in bacteriological and other scientific laboratories. There have been some difficulties with the apparatus, which is slightly top-heavy, as well as fragile, especially at the side arm and at the neck between filter and mantle. More serious, however, is its unadaptibility for use with small quantities of fluids. Up to this time, only one size filter and flask combination has been available for all types of work. This model (Corning #3990) has a 40-mm filter disk, a 60-ml reservoir above it, and a 250-ml receiving flask. No other filters, flasks, bottles, or tubes have been available with the T-S 29/26 glass joint. The filter apparatus is unnecessarily cumbersome, and the receiving flask too large for many filtering procedures, such as sterilization of small volumes of sera, drug preparations, and antibiotics for *in vivo* testing or *in vitro* assay. The same problem exists in filter-sterilization of growth factors, amino acids, rare sugars, and other chemical solutions for microbiological nutrition work, when perhaps only 5–10-ml volumes are to be sterilized.

UF filters of 10-, 20-, and 30-mm size, holding corresponding volumes of 2, 15, and 30 ml, as well as the largest model (40 mm with a 60-ml volume), are available, but without the mantle and joint. We have found it practical to seal off T-S tubes to desired lengths to receive 5-, 10-, and 25-ml quantities, using the already available filter mantle. It has also been found practical to seal smaller filters on the available mantles from broken filters or on new mantles for use with small quantities of fluids (2–10 ml,[2] Fig. 1). With the round-bottom collecting tube as a base, the apparatus will not stand alone. In practice, we use a clamp and ring stand to hold it or place the whole apparatus in a small wire basket, with the side arm protruding through the wire mesh to fasten to the vacuum tubing.

An all-glass, chemically clean, sterilizing filter for small volumes of fluid has advantages of economy in original cost, smallness in size, ease of handling, and recovery of greater amounts of the original fluid following filtration.

FRANK B. ENGLEY, JR.
University of Texas, Medical Branch
Galveston

[2] Prepared by Scientific Glass Blowing Co., Houston, Texas.

Rare Yucca

SEVERAL years ago R. B. Corey and I announced the discovery of a bifurcated hydrogen bond in the crystal structure of the amino acid glycine (*J. Am. Chem. Soc.*, **61**, 1087 [1939]). Now I wish to announce that a bifurcated yucca (*Yucca Whipplei*) has been discovered at Chilao Flat in the San Gabriel Mountains near Los Angeles, at an altitude of 5300 feet. Mrs. Thomas, of the Loomis Ranch, discovered the freak yucca last spring, and I photographed it (Fig. 1).

FIG. 1. Rare aberration of *Yucca Whipplei*, Chilao Flat, Los Angeles Co., Calif.

I would be glad to send seeds, sections, and more information on the plant to interested botanists. (I seriously doubt that there is any connection between bifurcated hydrogen bonds and bifurcated yuccas.)

GUSTAV ALBRECHT
Chapman College
Los Angeles, Calif.

Green Vision and Binocular Fusion of Yellow

RECENT evidence disproving the binocular synthesis of yellow apparently destroys a major bastion of the Young-Helmholtz theory of color vision. The existence of a true binocular yellow from pure red and green would allow the fourth primary to originate in the cortex (*1*), although it does not exclude the retinal synthesis of yellow now established (*2, 3*) as existing also. Hurvich and Jameson's experiment (*4*) indicates that a "pure green" (495 mμ) and pure red (495 complement), seen binocularly, do not mix to yellow. They infer that Prentice (*5*) in mixing "pure green" (530 mμ) and "red" (685 mμ) to evoke binocular yellow really must have used a yellowish green, whose yellow component survives binocular cancellation of the complementary *R-G* components.

The evidence presented (*4*) falls short of disproof for several reasons: (1) To really test the theory of binocular yellow, a red and green should be used which mix to yellow monocularly. The wavelengths used by Hurvich and Jameson were complements binocularly, and hence probably monocularly also (normally 495 mμ and pure red mix to white [*6*]). For these observers, then, pure green and red seem to form white. This is incompatible with trichromatic theory, and it is also hard to see that they have tested the question of binocular yellow. (2) The data of Dimmick and Hubbard (*7*) do show one class of observers who see unique green at 500 mμ ± 5, but also, by the same criterion, another class of observers who see unique green at 525 mμ ± 2. This strongly bimodal distribution in the spectral location of mid-greens may result from a small population but has not been brought out in the literature. (Whether the complement of unique red varies likewise is not known.)

In any case, ten investigators (*8*) have reported a large class of observers whose pure green is located between 509 mμ and 550 mμ—that is, well away from the complement (497 mμ) of pure red. These observers, probably over half the total normal population, should indeed see a yellow from binocular fusion of their unique greens and reds. (3) The problem is confused because of the various criteria (*7*) used for "green." "Pure" green may mean (*a*) a "unitary" green defined as stable in hue with respect to radial movement of the test spot in the field; (*b*) a "unitary" foveal green defined as stable in hue when the adaptive level or brightness is changed; (*c*) a green that most nearly satisfies both *a* and *b*; (*d*) a "psychologically unique" green defined as midway between the bluish-green and yellowish-green limens. Dimmick used criterion *d*. Criteria *a* and *c* were used by the investigators cited (*4*) as supporting Hurvich and Jameson. They themselves used criterion *d* but with a test field mainly parafoveal (test spot 1.2° × 32°) as in *a*. However, the yellow sense is weaker in the fovea than in the parafovea (*2, 9*), in spite of the supposed suppression of blue foveally by the macula lutea; hence, green wavelengths become yellowish radially and blues greener. A 32°-test spot looks yellower than one confined to the central 10° because of the averaging effect of the greater extra-foveal area. It may be for this second reason that Hurvich and Jameson find unique green at 495 mμ, rather than because they see 495 mμ as green, foveally. (4) Furthermore, Prentice (*5*) showed that binocular yellow does not appear desaturated, as by the cancellation of red and green components of slightly yellowish test colors, but looks as saturated as a spectrally pure yellow. This is true at least for those who see unique green around 525 mμ. We must conclude that Prentice's confirmation of a "cortical yellow" mechanism is valid. Modern experiments on binocular yellow should take account of the distribution of yellow sense, increasing outward from zero (*2*) at the central fovea. Prentice's experiment, if done with a 10′ test field instead of 6°, should fail centrally, but succeed peripherally.

The main theories of color mechanism (*8, 10*), 3-color (Young, Von Kries, Schrödinger), or 4-color (Hering, Müller, Adams), require a unique green around 497 mμ, and do not account at all for the large class of normal observers who center green at 525 mμ. A set of 3 primaries like those of Ladd-Franklin (*9*) better approximates the average of the two classes; but the system of 4 primaries shown by Motokawa's retinal data (*2*) gives a better theoretical frame to account for those who see the longer-wave pure green. A detailed retinal mechanism on this basis, which admits both classes of green observers, has been proposed (*3*). Both cortical and retinal yellow-synthesizing mechanisms would seem to exist.

More data are needed on the locus of unique green and of red-complement for the two kinds of normal green vision, to correlate them with the trichromatic anomalies and with practical color-matching. A seasonal variation in the blue-sense (*3*) (related perhaps to vitamin A) outside the macula lutea should not be overlooked in determining the yellow content of green. Pickford (*11*) has described a large class of individuals with deviant color sense (for green in particular), a defect genetically distinct from anomalous trichromacy and from dichromacy, not continuous with them, and not sex-linked in heredity. The deviations in Rayleigh balance of blue and yellow reported, although extensive and suggesting a wide scatter in locus of pure green, did not refer to psychological uniqueness. Pickford cannot be cited, therefore, as confirming this bimodal population for "unique green," which seems to explain the controversy about the existence of a "binocular yellow."

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References

1. HECHT, S. *Proc. Natl. Acad. Sci. U. S.*, **14**, 237 (1938).
2. MOTOKAWA, K. *Nature*, **167**, 630 (1951).
3. TALBOT, S. A. *J. Optical Soc. Am.* (in press).
4. HURVICH, L. M., and JAMESON, D. *Science*, **114**, 199 (1951).
5. PRENTICE, W. C. H. *J. Exptl. Psychol.*, **38**, 284 (1948).

6. HECHT, S. In C. A. Murchison (Ed.), *A Handbook of General Experimental Psychology*. Worcester, Mass.: Clark Univ. Press (1934).
7. DIMMICK, F. L., and HUBBARD, M. R. *Am. J. Psychol.*, **52**, 242 (1939).
8. JUDD, D. B. In S. S. Stevens (Ed.), *Handbook of Experimental Psychology*. New York: Wiley, 840 (1951).
9. WENTWORTH, H. A. *Psychol. Monogr. No. 183* (1930).
10. JUDD, D. B. *Doc. Ophthal.*, **3**, 251 (1949).
11. PICKFORD, R. W. *Individual Differences in Colour Vision*. London: Routledge and Kegan Paul (1951).

TALBOT presents four reasons why he believes the evidence offered by us falls short of disproof of the binocular synthesis of yellow. Our reactions to his four major points are as follows:

1) A real test of the theory that the yellow sensation results from the combined action of two receptor systems that are qualitatively unique in yielding green and red sensations, respectively, would seem to us to demand the mixture of stimuli that evoke pure green and pure red sensations when viewed independently. The requirement is the same whether the mixture is monocular or binocular. Our treatment of the problem as a specifically binocular one was dictated simply by the historical development initiated by the Hecht demonstration. To select stimuli for the binocular experiment by a criterion which requires that they mix to form yellow monocularly, as Talbot suggests, is, unfortunately, to select stimuli which, viewed independently, evoke yellowish-red and yellowish-green sensations. Just such stimuli have been used by Hecht, Prentice, and Trendelenburg. As we stated in our paper, we have no difficulty in confirming their results.

2) A possible bimodal distribution in the spectral location of pure green seems to us to be irrelevant to both the logical and experimental analysis. The spectral wavelength which evokes a pure green sensation may indeed differ for different observers: witness our own results. Whatever the wavelength of a stimulus that evokes a pure green sensation, by definition it excites no yellow. If our result cannot be generalized for normal observers, a visual mechanism would be required for which the mixture of pure green and pure red sensations would yield an achromatic fusion product when the green process is excited by one wavelength for one observer, and a yellow fusion product when the green process is excited by another wavelength for a different observer.

3) The problem is indeed confused because of the various criteria used for "green." Our criterion was that of "psychological uniqueness" (*d*), and every experimental datum cited in our summary table is a wavelength locus of a "pure hue" based on the same criterion of psychological uniqueness. Any values reported by the investigators we cite, for which different criteria such as *a* or *b* were used, were deliberately excluded from the table.

4) Prentice's stimuli were not selected on the basis of the uniqueness of the green and red sensations evoked by them. Consequently the fact that the peak transmission of his green filter occurs approximately at 530 mμ gives no clue to the spectral locus of pure green for his observers. The narrow band interference filters used by Prentice were selected on the basis of their nonoverlapping spectral transmissions, as a quite logical experimental step in answer to criticisms of the filters used in Hecht's original demonstration. Since there was no attempt to mix a psychologically pure green and psychologically pure red in the Prentice experiment, our analysis of the problem stands as originally presented.

On the basis of both our own experiments and our analysis of the earlier studies we can only reaffirm that, whether a cortical or retinal locus is assumed, "yellow-synthesizing mechanisms" appear to operate only when yellow is already present to some degree in either or both of the "red" and "green" mixture components.

L. M. HURVICH
D. JAMESON

Eastman Kodak Company
Rochester, New York

Book Reviews

Tables for Microscopic Identification of Ore Minerals. W. Uytenbogaardt. Princeton, N. J.: Princeton Univ. Press, 1951. 242 pp. $5.00.

This book as published had its inception in tables prepared by Westerveld, of the University of Amsterdam, before the war. Later, while working in the Mineralogical Department of the University of Stockholm, the author translated and reorganized the original tables, amplified them considerably, and brought them up to date in their present form.

The book will be found to be a usable laboratory manual for the microscopic identification of metallic minerals on polished surfaces. It tabulates in convenient form recent data in a field of considerable importance.

The author records tests for some 230 recognized minerals that are often opaque and also lists a considerable number of discredited species that might otherwise be confused with valid minerals. Mineral tables comprise approximately three quarters of the book, with the minerals arranged in order of increasing hardness, galena, chalcopyrite, and pyrite serving as reference hardness standards to define general groups.

Reflectivity, color, etch tests, Talmadge hardness, and occasional special tests furnish criteria for identi-

fication. The assembly of 441 references that give original data on the minerals listed will in itself be found most useful.

PAUL F. KERR
Department of Geology, Columbia University

The Structure of Physical Chemistry. C. N. Hinshelwood. New York: Oxford Univ. Press, 1951. 476 pp. $7.00.

In this book we see physical chemistry through the eyes of a long-time student and distinguished contributor to the field. The author traces the fundamental principles and the interconnections between them in a realm extending to the borders of science. We have pictured for us the molecular chaos in material systems that is measured by entropy and controlled by quantum laws. Maxwell's equations enter naturally into the explanation of the electrical nature of matter, and the theory of relativity relates matter and energy and so measures nuclear stability. Chemical equilibria and chemical kinetics are both examined in their broader aspects, and finally we learn something about the living cell and how it operates. Consciousness itself is examined and is clearly shown to be something quite beyond the scope of contemporary physics and chemistry.

The reader will no doubt enjoy Professor Hinshelwood's clear exposition, but he may often wonder how particular conceptions arose and where he can turn for a more exhaustive exposition of interesting points. He will be obliged to seek such references elsewhere.

Everything considered, one must say that here is a valuable book that should interest many in the broader aspects of physical chemistry.

HENRY EYRING
Graduate School, University of Utah

Metabolic Methods: Clinical Procedures in the Study of Metabolic Functions. C. Frank Consolazio, Robert E. Johnson, and Evelyn Marek. St. Louis: Mosby, 1951. 471 pp. $6.75.

This volume presents the methods which Dr. Consolazio and his colleagues have found useful in studying the metabolism of human beings. The techniques are described in detail, with instructions for operating apparatus and examples of calculations, so that anyone with basic laboratory training should be able to carry through the analyses. Following each section, a bibliography lists alternative methods, but these are not discussed.

Since the authors present only a single method for most determinations, it is unfortunate that several of their selections are outmoded. For example, the acetylene method for estimating cardiac output has been supplanted by the cardiac catheter. The authors might have increased the value of their manual by explaining the reasons for their choice of method. The addition of a short section giving the specificity of the technique and the expected order of accuracy would also be useful. Moreover, the organization of the book leads to difficulties. For example, the estimation of serum sodium or potassium is discussed in the section on "instrumentation" in connection with the flame photometer and under "biochemistry," but the use of the flame photometer is not even mentioned in the index under "sodium" or "potassium."

The authors are to be censured for suggesting (p. 21) that the same syringe be used repeatedly without sterilization in obtaining blood specimens from large numbers of subjects. Since this introduces a serious risk of disseminating infectious or serum hepatitis, no compromise with complete sterile technique should be permitted.

The purchase of this book is not recommended except for large libraries of research institutions. It cannot be considered as an adequate general guide for the study of human metabolic function, but its usefulness as an adjunct to more comprehensive reference books cannot be doubted.

PHILIP K. BONDY
School of Medicine, Emory University

Scientific Book Register

Hormones: A Survey of their Properties and Uses. Published by direction of the Council of The Pharmaceutical Society of Great Britain. London: Pharmaceutical Press, 1951. 220 pp. 35s.

Linear Transformations in n-Dimensional Vector Space: An Introduction to the Theory of Hilbert Space. H. L. Hamburger and M. E. Grimshaw. New York: Cambridge Univ. Press, 1951. 195 pp. $4.50.

Phase Microscopy: Principles and Applications. Alva H. Bennett *et al.* New York: Wiley; London: Chapman & Hall, 1951. 320 pp. $7.50.

Nucleic Acid. Symposia of the Society for Experimental Biology, No. 1. Reissue. J. F. Danielli and R. Brown. New York: Cambridge Univ. Press, 1951. 290 pp. $7.00.

The Measurement of Radio Isotopes. Denis Taylor. London: Methuen; New York: Wiley, 1951. 118 pp. $1.50.

The Battle for Mental Health. James Clark Moloney. New York: Philosophical Library, 1952. 105 pp. $3.50.

Energy Sources—The Wealth of the World. Eugene Ayres and Charles A. Scarlott. New York–London: McGraw-Hill, 1952. 344 pp. $5.00.

The Earth's Magnetism. 2nd ed. Sydney Chapman. London: Methuen; New York: Wiley, 1951. 127 pp. $1.50.

The Birds of Greenland, Part III. Finn Salomonsen; illus. by Gitz-Johansen. Copenhagen: Einar Munksgaard, 1951. Pp. 349–608 and 16 plates, with cumulative index. Accompanying map of Greenland, Dan. kr. 10.

Advances in Genetics, Vol. IV. M. Demerec, Ed. New York: Academic Press, 1951. 343 pp. $7.50.

The Conduction of Electricity through Gases. Rev. 3rd ed. K. G. Emeléus. London: Methuen; New York: Wiley, 1951. 99 pp. $1.50.

On Dreams. Sigmund Freud; new English trans. by James Strachey. New York: Norton, 1952. 120 pp. $2.50.

Metabolic Interrelations. Transactions of the Third Conference, January 8–9, 1951, New York. Edward C. Reifenstein, Jr., Ed. New York: Josiah Macy, Jr. Fdn., 1951. 294 pp. $4.00.

Anatomy of the Chordates. Charles K. Weichert. New York–London: McGraw-Hill, 1951. 921 pp. $8.00.

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Mar. 10–13. New Orleans Graduate Medical Assembly (Annual). Municipal Auditorium, New Orleans.
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Mar. 13–14. National Health Council (Annual). Roosevelt Hotel, New York.
Mar. 16–19. American Institute of Chemical Engineers. Atlanta Biltmore Hotel, Atlanta.
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Mar. 17–21. American Society of Tool Engineers. Industrial Exposition. Chicago International Amphitheatre, Chicago.
Mar. 17–22. Pakistan Association for the Advancement of Science (Annual). Peshawar University, N.W.F.P.
Mar. 19–21. American Association of Anatomists (Annual). Brown University, Providence, R. I.
Mar. 20–22. American Physical Society. Deshler-Wallick Hotel, Columbus, Ohio.
Mar. 23–27. American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists, Society of Exploration Geophysicists (Joint Annual). Biltmore Hotel, Los Angeles.
Mar. 24–27. American Chemical Society. Buffalo, N. Y.
Mar. 24–27. American Mosquito Control Association (Annual). Salt Lake City.
Mar. 27–28. American Association of Economic Entomologists, North Central States Branch. St. Paul Hotel, St. Paul, Minn.
Mar. 28–29. Eastern Psychological Association. Chalfonte-Haddon Hall, Atlantic City.
Mar. 29–30. American Psychosomatic Society (Annual). Chicago.
Mar. 31–Apr. 3. American Chemical Society. Milwaukee, Wis.
Mar. 31–Apr. 4. American Congress on Obstetrics and Gynecology. Netherland Plaza Hotel, Cincinnati.
Mar. 31–Apr. 4. Symposium on the Suprarenal Cortex. Colston Research Society. Bristol, Eng.
Apr. 4–5. National Aviation Education Council. Cooley Plaza Hotel, Boston.
Apr. 5–6. Eastern Sociological Society (Annual). Haverford College, Haverford, Pa.
Apr. 5–9. American Association of School Administrators (Regional). Boston.
Apr. 6–9. American College of Allergists (Annual). William Penn Hotel, Pittsburgh.
Apr. 6–9. National Agricultural Chemicals Association. Fairmont Hotel, San Francisco.
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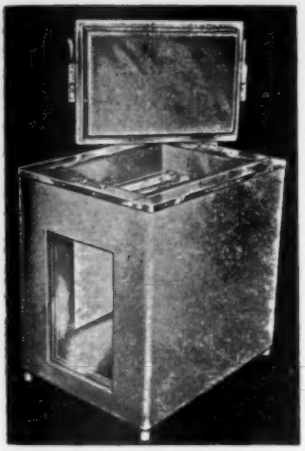

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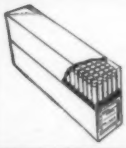

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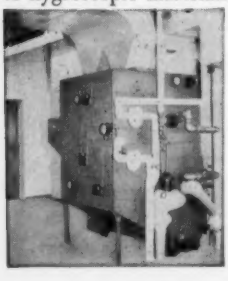

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Publications Received

Proceedings of the Second Annual National Noise Abatement Symposium. Sponsored jointly by The Acoustical Society of America, The National Research Council, The National Noise Abatement Council, and Armour Research Foundation of Illinois Institute of Technology on Oct. 5, 1951. Chicago: Technology Center, 1951. 108 pp.

The Production of Hybrid Corn Seed without Detasseling. Bull. No. 550. D. F. Jones and P. C. Mangelsdorf. New Haven: Connecticut Agr. Expt. Station, Sept. 1951. 21 pp. Illus. Free to Connecticut residents.

Racial Myths, The Race Question in Modern Science. Juan Comas. Paris: Unesco, 1951. (U. S. distrib.: International Documents Service, Columbia University Press, 2960 Broadway, New York 27). 51 pp. 25¢, 1s 6d, or 75 fr.

Relation of Sedimentation to Accelerated Erosion in the Missouri River Basin. Louis M. Glymph, Jr. Lincoln, Neb.: Soil Conservation Service, USDA, July 1951. 23 pp. Mimeo.

Relationships of Certain Genera of Fungus Gnats of the Family Mycetophilidae. F. R. Shaw and M. M. Shaw. Smithsonian Miscellaneous Collections, Vol. 117, No. 3. 22 pp. ***Symposium on Local Diversity in Iroquois Culture.*** William N. Fenton, Ed. Bull. 149, Smithsonian Institution Bureau of American Ethnology. Washington, D. C.: Smithsonian Institution, 1951. 187 pp. Illus. 75¢.

Sphecidae and Pompilidae (Hymenoptera), Vol. 2, No. 3. Collected by Mr. K. M. Guichard in West Africa and Ethiopa 1941–1948. G. Arnold. London: British Museum (Natural History), 1951. Pp. 95–183, 2 plates. 15s.

Sur L'Uniformisation par le Haut, Une Méthode de Conversion des Forêts Sauvages. Série Scientifique No. 51. C. Donis and E. Maudoux. Brussels: Institut National pour l'Etude Agronomique du Congo Belge, 1951. 77 pp. Illus. 100 Fr.

Words for Work. Handbook of trade terms for a tutoring program for new Americans. Boston: Jewish Vocational Service of Greater Boston, 1951. 140 pp.

Some Simple Procedures in Sterile Technique. Dorothy Pease. Brooklyn: Brooklyn College Bookstore, 1951. v + 109 pp. $1.50.

The Story of Pueblo Pottery. Museum Pictorial No. 2. H. M. Wormington and Arminta Neal. Denver, Colo.: Denver Museum of Natural History, Oct. 1951.

The Structure of the Galaxy. Symposium held in Ann Arbor, Mich., June 23, 1950. Leo Goldberg, Ed. Ann Arbor: Observ. Univ. Michigan, 1951. 84 pp. Illus.

Substances Naturelles de Synthese, Vol. 2. Leon Velluz, Ed. 138 pp. 1,250 fr; ***Images des Mondes Disparus.*** Jean Piveteaux. 157 pp., 107 figures. 650 fr. Paris: Masson et Cie., 1951.

Symposium on Biochemistry of Nucleic Acids. Sponsored by the Biology Division, Oak Ridge National Laboratory, April 13–14, 1950. Philadelphia: Wistar Inst. Anat. Biol., 1951. (Repr. from *J. Cellular Comp. Physiol.*, 38, Suppl. 1 [July 1951]).

The Wonderworld of Science, Books 1 to 8. (Illus. texts for elementary through junior high school students.) Rev. ed. Warren W. Knox *et al.* New York: Scribners, 1950. $13.96 for series, special prices for individual vols.

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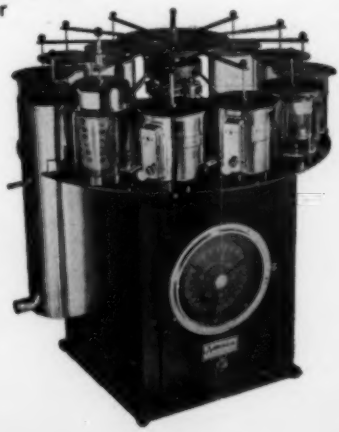

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